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The Making of A Weapon System

TACFIRE

1959-1978

NATIONAL DEFENSE UNIVERSITY
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THE MAKING OF A WEAPON SYSTEM:

TACFIRE 1959-1978

by

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Material for this study was collected largely from existing documentation (Selected Acquisition Reports (SAR's), Command Review and Assessment of Projects (RECAP's), and Historical Summaries) supplemented by extensive personal interviews with personnel currently and previously associated with the TACFIRE program, both on the government and contractor sides. In the interest of obtaining as much information as possible to make this a useful document, all interviews were conducted on a "not for attribution" basis.

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I. INTRODUCTION

For almost twenty years, the Army has been seeking to apply a significant degree of automation to the Field Artillery function. It now appears probable that a full scale production go-ahead for the Tactical Fire Direction System (TACFIRE) will be obtained in 1978, with systems going to field artillery units soon thereafter.

Why has this process taken so long? Is the Army guilty of mismanagement? Are the contractors at fault? While there are no simple answers, this case study will look back over the TACFIRE acquisition history and attempt to provide the reader with some insight into both the technical and managerial issues that have influenced the lengthy development history of this system.

Many "lessons learned" have come out of the TACFIRE program. Unfortunately, lessons learned too often become lessons forgotten. The Army falls short in its ability to retain a corporate memory and as a consequence is frequently doomed to repeating its past mistakes. Only those items that eventually rise to the level of enforced policy or regulation seem to achieve the necessary visibility and gain attention of managers and supporting staffs to effect enduring change and improved ways of doing business. Many other experiences and ideas lie fallow in the project files or go completely undocumented. This study of TACFIRE is written with the hope that the acquisition system can be improved as a result of the TACFIRE experience and that future project managers and their staffs concerned with the acquisition of computer-based systems can continue to benefit from that experience.

It is not feasible in one short document to provide an exhaustive study of the entire TACFIRE development program. Rather, the principal emphasis of this study is on the software development aspect of the system. To put this into proper perspective, major elements of the overall development program will be presented as well.

II. BACKGROUND

Establishing the Requirement

The first significant efforts aimed at applying automation to the battlefield began in the late 1950s. The US Army Electronics Laboratories at Fort Monmouth, New Jersey, were developing a family of digital computers for military applications. The FIELDATA systems,

as they were known, were being developed in a variety of configurations as general purpose militarized computers capable of handling a variety of applications. Already, functional proponents were studying the potential applications of ADP to their areas. In particular, the US Army Artillery and Missile School (USAAMS) developed an early Qualitative Materiel Requirement (QMR) for a Fire Support Sub System in 1959.

A series of "fire planning memoranda" were intiated by USAAMS in 1960, with contractual support for software development from Bunker Ramo, under the management of the Army Electronic Proving Grounds, at Ft. Huachuca, AZ. These early memoranda requirements resulted in WHITE PLAN I, a system concept (using a commercial IBM 7090 computer) demonstrated to DA and other service representatives to establish the feasibility of automating field artillery functions. To reinforce the concept, additional memoranda and software developments were added and demonstrated in WHITE PLAN II during March of 1961. By this time, the feasibility of automating the field artillery function had been well established.

Acting in response to a directive from the Department of the Army, the USACONARC directed the US Army Command and General Staff College to prepare a plan to integrate ADP into the field Army command information systems. With the assistance of several agencies, the USAC&GSC prepared a comprehensive plan under the title "Command Control Information Systems 1970" (CCIS70). Following USACONARC approval, the plan was sent to DA where it was formally approved on 3 January 1962 as the basic DA planning document for developing ADP systems for the field Army.

A reorganization of the Army in 1962 vested user responsibility for fire support requirements with the Field Artillery Agency (FAA) of the new US Army Combat Developments Command. While the Electronics Laboratories continued work on equipment development, the US Army Electronic Proving Ground at Fort Huachuca had been tasked to develop and test ADP systems under field conditions. A new series of highly detailed fire support memoranda were then developed under contract with Bunker Ramo. An Engineering Design Test followed, testing single thread applications programs one at a time. While this test demonstrated the practicality of automation of most of the major field artillery functions, it did not combine the individual applications into a prototype integrated system.

The fire support function was one of five tactical command and control functions the Army was examining as candidates for automation. Others under study included intelligence, operations, personnel and logistics, all of which had been addressed in the earlier CCIS-70 study. Under DA direction, the Command and Control Information System Group (within the Combat Developments Command) updated the original CCIS-70 plan and produced an Implementation Plan for Automatic Data Systems within the Army in the field (ADSAF). This plan

developed during 1964 and early 1965, realigned the tactical systems to be developed into a Tactical Fire Direction System (TACFIRE), a Tactical Operations System (TOS), including both intelligence and operations, and a Combat Service Support System (CS^3) which combined personnel and logistics.

Following DA approval of the implementation plan in May 1965, project management responsibility for the three ADSAF systems was vested in a new Automatic Data Field Systems Command (ADFSC) at Fort Belvoir. The ADFSC evolved from the earlier CDC Group and CCIS-70 and reported both to the Army Materiel Command as a materiel developer and the Combat Developments Command as a combat developer. Military systems directors (0-6) for each[1] of the major systems reported to the Commanding General/Project Manager. Meanwhile, the user role continued to be fulfilled by the Field Artillery Agency (FAA), and technical (hardware) support to the PM was furnished by the Electronics Laboratories under the US Army Electronics Command (ECOM) at Fort Monmouth.

Included in the ADSAF Implementation Plan was a set of formats proposed for documenting requirements for tactical ADP systems, called Functional System Design Requirements (FSDR). With the assistance of Bunker Ramo, the FAA took the series of fire support memoranda together with the documented software developed earlier and the test results from the White Plan and Engineering Design Tests and wrote a set of FSDR's which were eventually to become the basis for the TACFIRE specifications.

It was now necessary to bring the FSDR and QMR into agreement. To accomplish this some tradeoffs had to be made. The original QMR called for fire support (TACFIRE) systems at Division Artillery (DivArty), Battalion, Fire Support Element (FSE) and Battery levels. The ADSAF Plan had dropped out the FSE and Battery systems so they were thus eliminated from the QMR. In addition, input/output terminal devices were also deleted for the liaison officer, survey, and meteorological teams.

A new DA approved QMR for "TACFIRE of ADSAF" was thus promulgated in early 1966 as the culmination of several years of effort aimed at establishing the feasibility of automation of field artillery functions and maturing the requirement. A formal project management office had now been established along with an effective users' representative organization. When the comparative state-of-the-art of commercial data processing in the late 1950s to early 1960s is considered along with the cultural shock of automating real time tactical military functions, it is difficult to see how this process could have been shortened to any significant degree by the Army.

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Originally TOS and TACFIRE were combined, but later split into separate divisions.

TACFIRE Defined

Before going further into the development history, it would be useful at this point to define in brief what TACFIRE was to be as a result of the requirement refinement process described above.

TACFIRE is a system which applies automatic data processing techniques to the seven field artillery functions of technical fire control, tactical fire control, fire planning, artillery target intelligence, artillery survey, meteorological data, and ammunition and fire unit status. It also provides a capability for preliminary target analysis, nuclear target analysis, nuclear fire planning, chemical target analysis, and fallout prediction.

To perform these functions, TACFIRE computer centers are to be located at DivArty and at each direct support (DS) and general support (GS) firing battalion. Centers similar to the DivArty center may also be found at Corps Artillery and Field Artillery Groups. The heart of each center is a medium scale militarized digital computer and associated memory mounted in one or two S-280 shelters on a truck. Each center includes local input/output devices for control of the system by field artillery personnel.

At the battalion centers, an Artillery Control Console enables the computer operator to input data rapidly to the system and retrieve information from it. For example, Fire missions received from forward observers can be reviewed, and computed fire orders released to the batteries with provisions for approvals and modifications. A medium speed printer provides hard copy of all transactions while a Digital Plotter Map provides a four foot by four foot visual display of the tactical situation on standard military maps.

The DivArty Center has similar equipment plus an Electronic Tactical Display (Cathode Ray Tube, or CRT) which electronically augments the Digital Plotter Map. Each firing battery is equipped with a printer, the Battery Display Unit, to receive firing data and other information from battalion. Remote input/output devices enable forward observers, fire support officers and others to communicate with TACFIRE using standard tactical radios or wire and authentication techniques to provide a degree of security. Security for most of the links is provided by cryptographic devices.

Virtually all of the hardward devices described above are general purpose. They are tailored to the TACFIRE function through "software," the detailed computer programs which control their operation. Multiple applications programs are required for each type computer center to accomplish the seven major functions described earlier. A more detailed list of these programs and their functions is provided in Appendix A.

Besides the applications programs, two other types of software are required. Maintenance and Diagnositic programs are used to verify proper

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system functioning and to locate faulty circuit cards or assemblies when malfunctions occur. Finally, the most critical element of the software is the Operating System (OS) which controls TACFIRE, hardware and software, and integrates all of the many hardware and software elements into a cohesive system.

This, then, is an overview of the system the Army set out to develop and acquire following several years of requirements determination in the mid-1960s. The reader should appreciate that this was an exceptionally ambitious undertaking in that time frame. Real-time systems (i.e., systems whose performance are event driven with critical required response times rather than schedule driven) were not easily developed for the commercial world let alone for a battle-field environment, and this system was quite complex. Neither the militarized hardware nor the unique software existed at the time, and hence both would have to be developed concurrently.

III. CONTRACT DEFINITION PHASE

With the approval of the Director of Defense Research and Engineering (DDR&E), a competitive "Contract Definition Phase" was begun in 1966. Industry was invited to bid on a contract which would lead eventually to a design for an integrated TACFIRE. Subsequent guidance from the Army indicated that multiple contracts would be awarded, but restricted the bidding to prime contractors who were computer mainframe manufacturers. This late restriction caused some turbulence among the industry teams which were prepared to submit proposals. In one case, the prime contractor/subcontractor relationship between teamed companies had to be reversed as a result.

The imposition of the requirement that prime contractors be mainframe manufacturers may be indicative of an early misconception about tactical data systems on the part of the Army. In effect it reflected a viewpoint that TACFIRE was first and foremost to be a set of hardware machines. In fact, however, it will be seen that while the hardware was not free from problems, software problems were to dominate the picture completely, followed by problems in overall hardware/software system integration. A recognition of the criticality of software might have removed this restriction and permitted a better set of proposals to be submitted.

A Source Selection Evaluation (SSEB) Board met at Letterkenny Army Depot for approximately six weeks in January of 1967 to consider five proposals for the Contract Definition phase. Subsequently, in March of that year, three contracts were awarded to IBM (Federal Systems Division), Burroughs (Defense Space and Special Systems Group), and Litton Industries (Data Systems Division), all for in excess of $1 million each ($3.7M total). The study efforts were to last approximately twenty weeks resulting in a preliminary specification for TACFIRE (based on the FSDRs), as well as a technical approach to the system development including the contractor's recommendation as to the best language for developing the tactical software.

The three contractors submitted the results of their study efforts and it now fell to the Army to select the best of the three for proceeding into actual development. The same Source Selection Evaluation Board reconvened in August of 1967 to consider the three proposals. After approximately another six weeks, they reached the recommendation that Litton be awarded the follow-on effort.

It is important to understand that the contractor's proposal was to be the basis for the specifications for the follow-on effort. Some on the Government side have criticized the SSEB for not adequately comparing the contractor's proposal to the FSDR documents, although late in the evaluation period a special effort was directed at this. Future determinations of items falling within the scope of the contract or out-of-scope would have to be made on the basis of the specifications as they appeared in the contract, regardless of the content of the FSDRs. This eventually was to become a source of many problems for the Army.

IV. TACFIRE DEVELOPMENT

Development of TACFIRE was formally begun in December of 1967 with the award of the prime contract to Litton Industries. Litton in turn had teamed with two subcontractors to assist in the software development work. These were Planning Research Corporation (PRC) and Informatics.

A unique feature of the Litton contract was that it was the first award by the Army of a Total Package Procurement (TPP) type contract which covered not only development but subsequent production as well. Total value of the contract was a ceiling of $122.3M, including both R&D and production. One of the major reasons for awarding a TPP contract was the earlier unfavorable experience the Army had had with the FADAC computer when production was awarded to a contractor other than the developer, and major problems arose when one contractor attempted to manufacture the FADAC based on the design package produced by another. The TPP concept in effect ruled out future competition for production of the TACFIRE system. It also was designed to preclude "buy-in" by a contractor for the R&D phase with subsequent catch-up during production.

The original TPP TACFIRE contract with Litton was extremely ambitious. The entire span of the contract was for 69 months, with the first systems to be delivered to the Army for testing at the end of the first 22 months. This is probably indicative of a considerable degree of naivete at that time on both the part of the Government and of the contractor.

A significant aspect of the TPP contract also was the incentive structure which it contained. Incentives were included based on cost, schedule, and system performance. The latter was to be determined on

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the basis of a mathematical formula (developed by a separate contract) including various measurable system response times. One of the factors in the formula included a logarithm function which was originally unspecified (probably due to a typographical error) as to whether it should be the natural log (base "e") or common log (Base 10). At a subsequent meeting, the word "natural" was inserted. While this may at first seem inconsequential, it had the effect of multiplying the performance incentive factor by more than 2, and as a result the performance incentive to the contractor completely dominated cost and schedule considerations. With such a weighting, it is clear that a contractor will opt for improved system performance at the expense of increased cost and stretched out schedule whenever a tradeoff is to be made because it is in his financial interest to do so, especially when a $17M incentive was at stake as in this case.

A number of different players were now on the scene at various locations. The Army project manager in name was the Commanding General of the Automatic Data Field Systems Command; in fact, the TACFIRE Director within the ADFSC organization generally exercised the PM authority with a staff of about 10 people located at Fort Belvoir, VA. Technical support to the PM (primarily on hardware) came from the Electronic Laboratories at Fort Monmouth, NJ. The Combat Developments Command's Field Artillery Agency at Fort Sill represented the user. Also, the Artillery Center and School at Fort Sill had an interest in monitoring the development effort. At Fort Huachuca, AZ, a Cost Operational Effectiveness Analysis (COEA) group was charged with doing a COEA on TACFIRE. Finally, the Field Artillery Board was concerned with testing the system.

A significant PM decision resulted in the establishment of a Government resident development office at the Litton plant in Van Nuys, CA early in 1968. The PM on-site team was headed by a military O-5 (later O-6), with a civilian deputy and a three man software group. These were to be joined shortly by representatives from the FAA, the Artillery School, TECOM, and the ECOM laboratories, all as essentially independent representatives.

Software development quickly became the pacing item of the system. Management of the software effort was complicated by the fact that three different software development teams were involved. Litton, the prime contractor, retained some development responsibilities to enhance its internal capabilities. Their in-house team took on the task of developing the operating system as well as the DivArty and Battalion applications programs. FSE applications programs were subcontracted to Planning Research Corporation (PRC), while Informatics was responsible for support software, including implementation of a new high level programming language called TACFOL, designed by PRC. The split of applications programs between Litton and PRC would require careful coordination because the programs were interrelated.

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Management control from the Government point of view was to be maintained through a series of reviews, but no intermediate formal deliverable items were included prior to the actual system deliveries. The acquisition process at that time called for Research and Development Acceptance Tests (RDAT) at the contractor's facilities followed by Engineering Tests and Serviceability Tests (ET/ST) in a field environment.

The first formal review scheduled was a Preliminary Design Review (PDR) planned for the summer of 1968. For a number of reasons this review was not held until December of 1968. A major problem turned out to be differences of opinion over what the contract called for in the software. The FSDR documents were the primary source documents from the user's point of view, but they were not part of the contract. To confuse matters further, the extensive set of detailed specifications that had been developed during the contract definition phase were not formally part of the contract, since they had not been signed by either party. The only software specifications formally included in the contract amounted to a relatively brief overview specification set which left a great deal of room for disagreement between the contractor and the Government.

Prior to the formal PDR, the field artillery representatives undertook a detailed review of the specifications and the contract and generated nearly 1000 comments ranging from minor corrections to serious deficiencies which would, as they saw it, nullify the effectiveness of TACFIRE. Discussions on these items became confusing due to the multiple parties involved both on the Government side (PM, FAA, Artillery School) and the contractor's side (prime and subs). Official agreements could only be made between the PM/contracting officer and Litton as the prime contractor, but the other parties were deeply concerned as well. It appears that there was a great reluctance on the part of the PM office to make any changes beyond those which would correct obvious errors. In fact, no changes had been programmed for in the TACFIRE budget. Further, the PM office was heavily schedule oriented. Any major changes would involve both dollars and time, requiring Department of the Army approval. According to some who were involved, major cost/schedule changes may well have resulted in the death of TACFIRE as the PM saw it.

Nevertheless it soon became obvious to a number of people that the schedule called for by the contract was totally unrealistic, especially as far as software was concerned. It would be fair to say that both the Government and the contractor lacked the proper depth of qualified software developers and managers, and naivete prevailed. The first obvious evidence of slippages was the delay of the PDR until December of 68.

Besides the lack of appreciation for the time it would take to develop the software, inaccurate estimates of software size (numbers of instructions) led to gross underestimation of memory requirements.

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The initial estimates were carried over from the Engineering Design Test effort under Bunker Ramo. As a result, extensive hardware changes would later be required to provide sufficient on-line storage capacity. It may be that some foresaw the probability of increased memory requirements; if so, such considerations were dismissed due to their obvious cost impact.

Of the approximately 1000 deficiencies cited, Litton accepted the majority, the Government withdrew nearly 200, and eventually less than 20 became matters of contention. A baseline software specification set finally was arrived at following the December 1968 PDR. All was not to proceed smoothly from this point, however.

It should be noted that another change in the Army project management structure had taken place during this time frame. The Automatic Data Field Systems Command was supplanted by the new Computer Systems Command. From the point of view of TACFIRE, this change was largely cosmetic in that the TACFIRE Directorate continued to manage the program. The new CSC organization took on responsibility for non-tactical multi-command data systems in addition to the ADSAF program, however. This broadened the scope of responsibilities of the CG/PM and necessitated further decentralization of TACFIRE responsibility to the system director.

Research and Development Acceptance Testing (RDAT)

Litton had originally estimated that RDAT would begin 18 months after award of contract and last about 5 months. The Government development estimate similarly called for completion of RDAT in October of 1969. RDAT did not actually begin until February of 1970. It lasted just over two years, terminating in March of 1972 putting the program almost two and half years behind schedule.

The reasons behind this significant slippage are many, several of which have already been discussed such as the gross underestimation by all concerned of the magnitude of the software effort.

One of the most significant problems facing the development of any tactical data system has been changing requirements. TACFIRE has been no exception. Even though the concept formulation phase had produced a "matured" QMR statement, the data base of weapons and ammunition types which TACFIRE was to accommodate was continually shifting. Even with occasional freezes, the time would always come when TACFIRE had to catch up. Fortunately, this has not been a major problem for TACFIRE. More pertinent to the initial delays in RDAT was an increase in requirements for the Battalion system, partly due to initial underestimation of memory requirements. This necessitated an early (summer of 1968) change in the Battalion system to include the addition of random access drum memory units (RAM). This was a dramatic change for the system, with major software implications as well as cost. (With the TPP concept, the total procurement costs for over 100 drums had to be considered up front).

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Problems with the Digital Data Terminal (DDT) caused further delay. Litton was subsequently directed to drop the subcontract effort on the DDT by RCA and build it in-house. A delay in availability of RAM drum units also had a negative impact.

Many of the ills of concurrent hardware, programming support software and applications software development contributed to the delays. Real time operating system software for instance, must be intimately structured to complement the physical hardware. Original software development had to be done using a commercial IBM system as host machine until real tactical hardware became available. Compilations and assemblies were done on this system and the only software testing that could be accomplished was done using a software interpreter to simulate the tactical hardware. Transition from the programming support system A (PSSA on IBM hardware) to programming support system B (PSSB on Litton hardware) did not go according to plan.

More than anything else, however, the serious slippages of the TACFIRE program through the completion of the RDAT phase must be charged as management failures on both the part of Litton and the Army. These same failures were also to be responsible for additional slippages that would occur later as a result of problems that would show up during ET/EST.

TACFIRE development was planned to be monitored, as mentioned earlier, by a series of reviews, first Preliminary Design Reviews (PDRs) and then Critical Design Reviews (CDRs). The design of the system was to be guided by Part I specifications (design to), to be followed later with Part II specifications (build to) which would reflect the final design. Testing would begin with Preliminary Qualification Tests (PQTs) for groupings of computer program modules, and move on to Formal Qualification Tests (FQTs) of complete software packages. All of this was tied together in a Configuration Management Plan which called for a Software Review Board (SRB) to carefully control the progress of the system and changes made thereto. This management approach could have been quite successful if followed through, but it fell apart completely in implementation.

The original Litton software effort including subcontracts was scoped at about $15 million. Management quickly cut this to $7 million and then in the competitive crunch included only $3.5M in their final bid price. This ensured that inadequate resources would be available for software and doomed the software management approach to failure. The Configuration Management Plan was never really implemented, the SRB never constituted, and sufficient software personnel were not available, especially in the contractor program management office.

While it originally appeared that the two experienced software subcontractors (PRC and Informatics) would be substantially involved

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in the development of the software, in fact their involvement was minimal with the bulk of the critical work reverting to the relativly inexperienced Litton group.

For its part the Army management team was no better in its implementation efforts. The PM staff was equally lacking in software experience and depth. Tests by the contractor were inadequately monitored and the results of both tests and design reviews were not well documented. Insufficient effort went into reviewing test plans as well. Consequently, problems in PQT's often went undetected and filtered on through into FQT's. In short, any semblance of real control was completely lacking. The problem was compounded by lack of continuity on the part of the Government personnel from one review or one test to the next.

Management appreciation for the crisis in software was lacking in part due to the absence of measurable milestones visible to the government between June 1968 and January 1970. When the first series of FQT planning meetings began in May 1970 the problem finally began to come into focus. By the end of the year, the PM was ready to acknowledge the slippage and Mod #50 to the contract on 29 December 1970 formally rescheduled the start of ET/EST for May 1971 (from the original Oct 69 date) and stretched the TPP contract out a total of 30 months. Pressures were now applied to Litton to tighten its management controls and apply resources to implementing its software management plan.

It was also during the RDAT period that yet another change in project management structure occurred. Beginning in late 1970 and on into 1971, the Army established the Office of the Project Manager for Army Tactical Data Systems (PM, ARTADS) within the Electronics Command at Fort Monmouth, NJ. PM responsibilities for TACFIRE and TOS were shifted from the Computer Systems Command at Fort Belvoir to this new PM office. At the same time, responsibility for monitoring the development of the software for these systems remained with CSC. The new PM, ARTADS thus found himself with PM responsibility for TACFIRE, but the software management resources he needed did not belong to him; in fact CSC as a major Army command was not even under the control of the Army Materiel Command (AMC). In theory any major disagreement between PM, ARTADS and CG, CSC over TACFIRE software management would have to be resolved at the Vice Chief (or Asst Vice Chief) of Staff level. The lack of collocation of the organizations exacerbated the situation.

Formal Qualification Tests actually got underway in the first quarter of FY 72 (mid-1971), further delaying the start of ET/EST. This was the first time the Government had overseen the actual performance of software. Not unexpectedly, numerous Operational Deficiencies (ODs) were encountered, the most serious of which were in the applications software. ODs were separated into those which required fixing early, those which could be waived, and those requiring a formal Engineering Change Proposal (ECP to bring the system and the specifications into agreement. Reruns of the FQTS continued into early 1972

to clear the outstanding ODs. A test plan was also developed to allow demonstration of the total integrated TACFIRE system (hardware, software and communications) as the culmination of RDAT.

Early indications of system reliability problems were also beginning to appear. The target for Mean Time Between Failures (MTBF) was set at 150 hours, with a Mean Time to Repair (MTTR) of 30 minutes, as per the QMR and system specifications. The electromechanical equipment in TACFIRE provided the most problems. Of course, it was expected that initial performance would fall short of these objectives and that reliability would improve as time went on.

Once again the contract had to be adjusted to catch up with reality. On 6 Jan 1972 Mod #60 was signed calling for ET/EST to start in March 1972 with the first production release scheduled for April 1973. An additional 12 months was added to the Mod 50 schedule, bringing the total extension to 39 months between the beginning of ET/EST and the issuance of a production go-ahead.

After reviewing the status of hardware and software testing as well as the availability of trained military personnel, the PM set 1 April 1972 as a realistic target date for the beginning of ET/EST. Negotiations on a system delivery date had been difficult and at one point (Sep 1971), the Government had unilaterally instructed the contractor to deliver on the 1st of April 1972. The contractor finally agreed in Mod 60 to this date as a delivery date for the ET/EST systems which would include a DivArty set, three direct support artillery battalion sets, one general support Bn set, and a missile battalion set.

The total integrated system test began in February and continued through late March of 1972. PM personnel supervised a "military operational test" of the ET/EST systems in the Litton plant on 29 March 1972. The successful completion of that test resulted in the preliminary acceptance of the TACFIRE system for ET/EST.

The PM now reassessed the total situation prior to making a decision as to whether or not the system was truly ready for ET/EST. On the software side, while there were still problems remaining, the major ones identified during the FQT series had been cleared and it appeared that reasonable performance could be anticipated. Hardware problems had similarly been reduced to manageable proportions and the known limitations would be acceptable. Spare parts were not completely up to the planned levels, but the maintenance concept had generally proven sound and a maintainability demonstration had been successfully completed. After coordinating with the tester (TECOM) and user (CDC), the PM deemed the total risk situation to be acceptable and decided to proceed into ET/EST.

An interesting side issue developed with the contractor over whether or not the "development" phase of the contract had now been completed. This status affected certain contractor support activities and reporting requirements. Litton maintained that development terminated on Army acceptance of the ET/EST systems, while the Army's position was that development continued until a production go-ahead was given. This issue, somewhat unique due to the TPP contract, remained in contention for many months. In the meantime, the Army dictated procedures to be followed for the control and maintenance of software during the ET/EST phase.

Engineering Tests/Expanded Service Tests (ET/EST)

TACFIRE was now entering what was to be perhaps its most interesting phase from the point of view of a weapons system acquisition history. ET/EST was to begin in April 1972 and run into February 1973. Unanticipated problems were to arise, however, with unique and interesting management solutions ensuing in response to those problems.

By 6 April 72, two battalion systems and a DivArty system had been delivered to the White Sands Missile Range, New Mexico, a battalion system had arrived at Ft Huachuca, Arizona, and another battalion system was in place at Ft Sill, Oklahoma. The set at Ft Huachuca was to undergo electromagnetic compatibility and vulnerability tests as part of the Engineering Test (ET), and on completion be shipped to Ft Sill. Similarly, the White Sands set would also go to Ft Sill on completion of ET to augment the operational test facilities.

Expanded Service Tests (EST) got underway at Ft Sill on 8 April. The Field Artillery Board began exercising the system to determine its operational suitability. Software and hardware problems began showing up almost from the start. Also, shortcomings in the draft technical manuals seriously compounded the operational problems. The situation was so bad that tests were suspended for more than a month beginning on 27 April, to permit the contractor to perform necessary maintenance.

At White Sands, the ET system ran into similar problems - again both hardware and software deficiencies. Here, too, the decision was made to suspend testing as of 1 May to give the contractor a chance to solve at least the most critical problems.

In the hardware area, mechanical problems were plaguing the fixed format message entry devices (FFMEDs), the plotter maps, the keyboards and the printers. Power supply problems were also responsible for an alarming number of system failures, along with cables. Finally, RAM memory capacity for the battalion system showed signs of strain.

Software problems were the most serious, however. Under some conditions the system would issue erroneous fire commands or none at

all. Fire planning procedures frequently produced results wherein
targets were omitted, fires exceeded, or available fire units over-
looked. Some of the fire support element programs were virtually
unusable. Ballistic solutions for very short ranges or high angles
were generally inaccurate.

Early in June, following an intensive period of hardware mainten-
ance and re-engineering, as well as extensive software changes,
testing was resumed. Problems continued to show up and it soon
became apparent that the entire test plan could not be successfully
implemented. A high level management review was in order.

On 19 July 1972, the PM convened a senior level management
meeting to review the situation. General officers from TECOM, the
Field Artillery School, Computer Systems Command, and Combat Develop-
ments Command participated, in addition to PM, ARTADS. At issue
was whether testing should be continued or terminated, with the
latter course of action carrying serious implications about the
future of the TACFIRE project. On the positive side, mobility testing
and environmental testing had gone well and there was something to be
gained by continuing at least some portions of the testing. Out of
this meeting came a decision to continue with limited testing into
September, at which time a new software tape would be made available
by the contractor and full ET/EST could resume.

Additional corrective measures were also directed as a result
of this meeting including an accelerated delivery of the system from
WSMR to Ft Sill, establishment of an Equipment Performance Report (EPR)
review task force, accelerated interim software corrections with a
schedule of 5 intermediate revised tapes, and creation of a user
guidance group.

Serious problems continued to arise. In August, it became evident
that it would be impossible to complete sufficient testing to enable
a production decision to be made by the required date of 1 April 1973.
The Department of the Army (DA) was now brought in and a series of
briefings and reviews was begun. Meanwhile, formal testing continued
on an intermittent basis only.

Following meetings in the Pentagon on August 10th and 14th, DA
endorsed most of the actions already taken by the PM. The most
significant outcome of these meetings was a formalization and strength-
ening of the user guidance role that had recently been initiated. On
17 August, DA sent out a message formally designating the Field
Artillery Center as the "using agency for TACFIRE" with a number of
specific responsibilities. Most important, the designated user was
charged with the task of reviewing each EPR as written by TECOM, to
"determine from the user standpoint the minimum acceptable level of
performance required in each deficient area..." Further, the user

would "establish for PM, ARTADS the relative priority from the user viewpoint for correcting deficiencies and shortcomings identified in EPR's." User determinations were to be promulgated by message to all concerned.

The significance of the designated user cannot be overemphasized. Here for the first time was a single focal point within the Army empowered to speak with virtually final authority on modifications to the TACFIRE requirement pertaining to the pure field artillery function. Items that impacted beyond the field artillery domain had to be coordinated with CDC before a user determination item could be published, but these were a small percentage.

Heretofore, the tester had little choice but to cite a deficiency each time the system failed to measure up to the letter of the QMR, now over 6 years old. This new procedure allowed the designated user to ask not "does the system do what the QMR says it must," but instead "is the performance of the system adequate to fulfill the needs of the field artillery?" If the answer to the latter question was yes, then the "User Determination Item" so stating it became a de facto modification of the requirement. Each EPR was to be analyzed, a determination made and a rationale given for the determination, all to become part of the permanent record. (Representative User Determination Item messages are included in Appendix B).

One of the major benefits achieved by this system was that it forced a renewed challenge of the TACFIRE requirements. If a requirement did not stand up to careful scrutiny, a simple mechanism was now available to modify the requirement accordingly. Equally important was the psychological factor. No longer was TACFIRE simply a system being developed by the materiel developer to meet the wish list of a remote and intangible "user." The user, now well identified, became a true system proponent and in effect a part of the development team. The independent tester role, however, remained separate to provide for necessary checks and balances.

Not only had the production decision date of April 1973 become totally impractical, but the production quantities planned when the TPP contract was signed in 1967 no longer reflected the needs of the Army in view of changes to the force structure. Faced with continued technical problems and obvious contractual inadequacies, the PM set in motion a process aimed at reaffirming the Army's needs for TACFIRE and making the necessary reorientations to the overall TACFIRE program.

Several alternative courses of action were presented to DA by the PM in October 1972. These ranged from continuing the program unchanged to termination, with a middle ground of restructured alternatives. Among the latter were an alternative stretching out and repricing full scale production, two alternatives calling for completion of

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development with either no production or a procurement package aimed at a separate competition for production, and an alternative providing for a Low Rate Initial Production (LRIP) only, with options for full scale production.

Termination was still a very real alternative at this time. It could not be discounted without a review of the Army's true requirement for TACFIRE. To address this, DA established in late October a "Senior TACFIRE User Validation Committee" (TACVAL) consisting of general officers and chaired by the CG, 1st Infantry Division. The TACVAL committee met at Ft Sill, OK from 2 through 6 November, and on 15 November their recommendations were presented to a special ASARC. They had reaffirmed the need for TACFIRE and recommended continued development on an extended schedule.

The special ASARC accepted the recommendations of the TACVAL committee and convened a second committee (TACVAL II), chaired by PM, ARTADS to evaluate four alternative courses of action developed by DA. This committee presented its findings to a second special ASARC on 27 November 1972.

The course of action recommended and approved by the special ASARC contained three major elements. First, it called for completion of the development of TACFIRE, ruling out termination at this time. Second, it directed new scheduling to allow correction of system deficiencies and retesting, plus changes to the procurement quantity. This would require a modification to the contract. Finally, the ASARC directed that the project be brought into line with the new acquisition policies which had been published by the Army in AR 1000-1 on 30 June 72.

One of the most significant aspects of the new AR 1000-1 was a revised testing structure. Testing was now divided into two broad categories of Development Testing (DT) and Operational Testing (OT). DT focuses on determining how well the system satisfies the detailed criteria set forth in the requirements documents and is conducted by TECOM as an independent development tester (within AMC). The purpose of OT is to answer the question: "Can a unit equipped with the new system accomplish its mission in a tactical environment?" The US Army Operational Test and Evaluation Agency (OTEA) was created as an agency separate and distinct from the developing/procuring command to be responsible for OT. Three series of tests, DT/OT I, II, III would be conducted through the development cycle.

The next set of formal tests that TACFIRE was to undergo would now be restructured into a DT/OT II series. The PM recognized that extensive hardware and software modifications and corrections would be required before the system would be ready for these tests. During the stretched out development time now planned, it would be necessary to use the prototype systems for an intensive and continuous cycle of problem

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identification, correction and informal testing. This was to become known as the "Find, Fix, and Test" period of the development of TACFIRE.

A final hurdle remained before the recommended restructuring of the TACFIRE program could be implemented. Department of Defense approval was sought in a briefing presented to a special DSARC on 11 January 1973. The DOD group directed that the alternatives considered be further developed and presented formally in a revised Development Concept Paper (DCP) for decision. Accordingly, PM ARTADS submitted a revised DCP with a recommended course of action consistent with the approach that had previously been approved by the special ASARCs.

The revised DCP was approved by the Deputy Secretary of Defense on 30 March 1973. The PM now had authority to renegotiate the contract to increase development time and, significantly, alter the type of contract from the controversial TPP to a Cost Plus Fixed Fee (CPFF) type for development, with options for subsequent production. This would give the Government the flexibility of not going ahead with production if the outcome of development testing was unsatisfactory.

In his approval of the DCP recommendation, the Deputy Secretary of Defense added a requirement that the Army develop a plan that would permit subsequent competition for production on completion of the test and evaluation phase of TACFIRE. Considering the complexity of the program and the previous production commitment under the TPP concept, a plan to inject meaningful competition into the program at a future date would require careful thought and prove to be a challenging effort.

Negotiations with Litton had been going on in anticipation of the DCP approval, enabling Mod 88 to the contract to be signed effective 31 March 1973. The contract was converted to a CPFF type development contract as desired. The production commitment was deleted in favor of an option for Low Rate Initial Production (LRIP) and an option for full scale production, both with ceiling costs negotiable downward. An option for a competitive procurement data package was also included with the price to be negotiated. The development phase was extended by eighteen months to correct deficiencies (at the contractor's expense) and also to add capabilities identified by the user as essential. The Government also achieved a reduction in the termination costs (by 1/3) in the event of cancellation. In trade for these considerations, the development costs were increased considerably (about 15%), but the new figure was a ceiling above which the contractor would absorb all costs.

The new schedule now placed the production decision in the December 1974 time frame, after a six month DT/OT II (April through October) and a suitable evaluation period. Assuming a successful DT/OT and ASARC/DSARC approval, the PM planned to recommend LRIP be initiated in December, followed by a DT/OT III in January 1976, with the possibility of full scale production beginning in February 1977. Total slippage in the program since the original contract was signed was now up to 65 months.

The signing of Mod 88 climaxed perhaps the most trying stage of the TACFIRE program. The many software and hardware problems had not all been solved by any means, but the restructuring of the overall program brought with it a reasonably sound approach to the continuation of the development phase, with some hope for success.

Find, Fix and Test

During the first twelve months of the post-Mod 88 period, the program was to shift into the Find, Fix, Test mode briefly described earlier. Architected by the Project Manager as an innovative development approach, this mode of operation was unique in several ways. As a modified form of customer test, the contractor had control of the systems approximately three fourths of the time to develop and test solutions to the deficiencies that had arisen during ET/EST. The remaining quarter of the time the Government had control of the system to validate the contractor's corrections and attempt to discover other areas where correction might be required. Time was shared on a daily basis for these purposes. A detailed memorandum of agreement (Appendix C) between Litton and the PM spelled out the procedures and schedule to be followed.

In the traditional system development, the contractor controls the equipment for an extended period of time (months or years) to develop the system. Then the system is turned over to the Government for an intensive and lengthy series of formal tests by the testing organization. At the conclusion of these tests, the system together with a list of deficiencies is returned to the contractor for correction.

With a system as complex as TACFIRE, this may well be an inherently unstable development-testing cycle. Correcting hundreds of deficiencies at a time, with no intermediate feedback from the user may result in the introduction of an equal number of new deficiencies. Find, Fix and Test sought to collapse that cycle into much shorter intervals, handling fewer problems at a time, and with the aid of the user and tester, providing early feedback to the contractor as to the adequacy of his fixes.

We have already cited the critical supporting role now being played by the designated user. Find, Fix and Test brought with it the equally critical supporting role to be played by the tester (TECOM). Resources of the testing community were employed to aid the developer in problem identification and correction validation, thus further expanding the development team. Formal testing would later be conducted in the traditional manner (DT/OT II) to ensure that the testing process had not been compromised. It may be that a form of Find, Fix, and Test is essential in any computer system development project comparable to TACFIRE in complexity.

Solid progress was made throughout the ensuing year of Find, Fix and Test. In January of 1974, the PM began an assessment of system

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status to determine whether or not DT/OT II could begin on 1 April as planned. The general conclusion was that the majority of the problems had been corrected, but others remained as outstanding deficiencies.

In coordination with the designated user, all problem reports not yet cleared up were reviewed to obtain agreement as to those which required correction prior to the start of DT/OT II, those that could be corrected during the DT/OT II period, and those of lowest priority which could be postponed until the subsequent production phase.

The PM had been pursuing a strategy of parallel developments and product improvements to solve the more critical hardware problems in an all out effort to improve system reliability. This allowed for continued usage and minor upgrades of existing items of equipment until such time as a major improvement could be made by insertion of a product improved item or a totally new replacement item. A number of TACFIRE equipments were being upgraded in this manner, including the FFMED, the electronic line printer, and most recently the RAM drums. In the case of the RAM, a priority effort was underway to permit eventual replacement of the drums with all electronic Mass Core Memory Units (MCMUs) which would significantly alter the system performance and memory capacity. Major software changes would also be required to accommodate and take full advantage of the MCMUs. The parallel development approach minimized technical risk, while providing considerable flexibility to the project manager. Where different vendors were involved for the old and new items, an obvious competitive advantage was also realized.

Other hardware problems such as those associated with the power supplies were yielding to intensive engineering programs aimed at making the existing equipment perform in accordance with design criteria. Here, too, reliability was inching upward.

Each of the revised software tapes had brought with it considerable improvement over its predecessor with numerous software deficiencies being corrected. A final DT/OT II version was scheduled for March 1974. It would include provisions for testing the MCMU which had already successfully passed basic qualification tests the preceeding August.

At the end of January 1974, the PM reported to the Commanding General of AMC that he felt that DT/OT II could commence on 1 April. His plan called for Litton to turn the system back to the Government at the end of February, with the month of March being used to wrap up final preparations for the test series. An updated form DD250 would document the specific known deficiencies in the system that Litton would subsequently be required to correct, but which would not prohibit DT/OT II from beginning.

Development Test/Operation Test II (DT/OT II)

As it turned out, DT/OT II did not officially begin until 14 May 74. The reason for this delay was not technical problems, but another

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contractual disagreement between the government and Litton. Litton had announced that their understanding of the language of Mod 88 was that signing the DD250s constituted final acceptance of TACFIRE except for deficiencies specifically cited. The Government maintained that final acceptance could not occur until after DT/OT II was completed and all non-compliances with contractual specifications could be determined. This would keep the club of default over the contractor's head on into the DT/OT III test series preceding production.

The DD250 situation remained a standoff. Both parties wanted to get on with the testing to keep the program moving. Since the dispute centered on what the meaning of newly signed DD250s was to be contractually, the problem was effectively sidestepped by the simple expedient of not signing a new set of DD250s. This amounted to a de facto victory for the Government since Litton was not relieved of any responsibility for system deficiencies, but at the same time it left the door open for Litton to make a subsequent case if they so desired. A separate agreement was executed to establish support responsibilities of the contractor and liability responsibilities of the Government for the equipment during the test period.

The OT II operational test was conducted by OTEA during the period 8-26 July 1974 with generally successful results. One of the primary operational objectives was to demonstrate improved system reliability. As intermediate goals on the way to achieving the specification requirement of 150 hours MTBF, 30 hours MTBF had been the target to permit entry into DT/OT II and 90 hours required at the conclusion. The actual values were nearly 50 hours MTBF when the tests began, rising to 123 hours at the conclusion of DT/OT II. (It should be noted that reliability values change in one of two ways: on the one hand the performance of the system changes, while on the other hand the "chargeable" failures may change as a result of a scoring conference. Both of these factors were present and contributed to the dramatic reliability growth.)

By the end of September, the bulk of DT/OT II had been completed. TECOM wound up the DT phase and the test series terminated officially on 8 November. The PM, the user and test communities now began massaging the test results and preparing for the upcoming ASARC and DSARC presentations.

In preparing for the ASARC/DSARC III series, Department of the Army used the Red Team approach to shake down their alternatives. The alternatives considered were (1) terminate the program; (2) continue under the present contract, going on into LRIP and then Full Scale Production with Litton; and (3) exercising the LRIP option with Litton, but providing the basis for competition in FSP by acquiring a technical data package. Two variants on alternative (3) were for: (a) full competition for FSP based on the LRIP design; and (b) competition for FSP based on product improved designs of selected subsystems, to include the computer subsystem. This latter alternative (3b) was the PM's preferred alternative.

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The preferred alternative in part reflected the PM's strategy in response to the earlier OSD guidance to show how competition could be brought into the program. Full system competition did not appear to be practicable for a system of the size and complexity of TACFIRE. Individual subsystems or separately identifiable end items could probably be competed effectively, and in fact this was a natural extension of the parallel development of product improved items already being accomplished.

Initially the Red Team critiqued the PM's alternatives, and subsequently the team was directed to assist in refinement of the alternatives. During the actual council sessions, the Red Team made an independent presentation of its areas of concern over the preferred alternative. These included the additional R&D costs to be funded, the practicability of developing and using technical data packages, and the effects of subsequent design changes on the validity of previous test results. This use of the Red Team approach seems to have been reasonably constructive, although the costs (100K) were probably excessive for the results obtained.

V. LIMITED PROCUREMENT

TACFIRE took a major step forward on its long journey to the field when the DSARC III and Deputy Secretary of Defense approved the Limited Procurement (LP) of 14 additional TACFIRE sets on 28 January 1975. This decision was a modification of the PM's preferred alternative. There is significance in the fact that the system went into "LP" rather than "LRIP." LRIP implies that a production line is being brought up prior to commencement of Full Scale Production. The 14 sets would enable an extensive DT/OT III test series to be performed before the FSP commitment was made. An ASARC/DSARC IIIa was planned to effect that decision.

Several changes to the system were also directed by the DSARC III. One of the most significant was the conversion from RAM to an all MCMU memory system. Another was the substitution of a new all electronic Digital Message Device (DMD) for the electromechanical FFMED which the user had found unsatisfactory. Other changes included an improved line printer, display editor and keyboard. The impact of these changes was minimized by the parallel efforts that had been going on in these areas as described earlier, and consistent with the PM's preferred alternative.

With OSD approval in hand, the PM was able to exercise the option provided by Mod 88 for 14 additional TACFIRE sets. The contractor had submitted a detailed proposal for both LRIP and FSP the preceding May and negotiations since that time had worked out most of the details. A supplemental agreement was executed on 30 January 1975 to begin this new work.

The overall TACFIRE program schedule had now grown by another 36 months, bringing the total to 101 months beyond the unrealistic date

programmed when the original contract had been let in 1967. The LP phase with a First Article Test (FAT), Force Development Test and Evaluation (FDTE), DT/OT III, and following ASARC/DSARC IIIa added about 15 months, plus an additional nine months to incorporate changes to the Communications Control Unit (CCU) which had been added to the system earlier, and to update the systems data base to service all required weapons. Finally, a 12 month stretchout in the Full Scale Production phase was anticipated. These would all be reflected in Mod 130 to the contract as of June 1975.

Software Management and Incentives

While major strides had been taken toward developing a fieldable set of TACFIRE software, serious deficiencies remained in many areas. The awkward working relationship between the two commands involved (CSC with software responsibility and ECOM with hardware and system responsibilities) has already been mentioned and this undoubtedly had contributed to the difficulties of managing the software development efforts. Reports generated at the CSC working level were subject to sanitizing and softening as they bubbled up through the organizational heirarchy. The PM's knowledge of software status had suffered under this arrangement.

One of the biggest problems under the split management arrangement was the dominance of administrative data processing personnel in the Computer Systems Command. There are major differences between batch processed financial, personnel and logistical data processing systems and on-line real-time command and control systems. As an example the operating system for one is vastly different from the other. In this area alone ARTADS experienced great difficulty in working with CSC personnel unfamiliar with real-time software. Differences in programming languages and hardware structures were also significant. The problems between the two organizations were compounded by attempts within CSC to impose its internal documentation standards on the contractor. In some cases the PM found CSC personnel issuing instructions which amounted to constructive changes to the contract, creating an intolerable situation for a project manager.

A hidden blessing in the stretched out TACFIRE development cycle was realized in that newly assigned personnel frequently had previous TACFIRE experience. This improved the corporate memory situation and enhanced the experience and expertise levels as well. As an example, the TACFIRE director in the ARTADS organization at the time of transition into LP had been involved in the early stages of the program first as part of the CDC team and then in the startup of the ADFSC office.

The ARTADS organization also benefited from the assignment in 1974 of an officer who had been in the resident development office with Litton shortly after the contract was awarded, representing the

Artillery School and assisting in software monitoring. He came to TACFIRE fresh from graduate school having acquired a Master's Degree in computer science. For the first time the PM had directly available to him an individual with both the experience and technical background required to really come to grips with the software management problem and this became his assignment.

With his own software manager now on board, the PM drew up a comprehensive software management plan addressing within the structure of the existing contract (and making the best of the ECOM/CSC split responsibilities) how software would be managed, the milestones, documentation, review process and so forth. Key to the overall management concept was a new incentive program for software.

Entering into the LP phase, the PM made available $1M to be used for incentives. The previous incentives in the program had actually turned out to be counter-productive and so extreme care went into considering how to structure incentives properly in the new contractual phase. Hardware and software incentives were both considered, but it quickly became apparent that the greatest program leverage could be achieved in the area of software. In retrospect this was one of the best decisions made in the TACFIRE program.

Earlier lessons learned contributed to the structuring of the new incentive package. One area of difficulty is in measuring the performance of the contractor to determine whether or not the incentives are to be paid. Generally this involves the establishment of a formal awards board which must make subjective judgments. In this case the need for a board was avoided by making the criteria extremely simple, thus reducing the evaluation process to an equally simple yes/no determination.

Both lessons learned and ASARC guidance militated against giving the contractor a large number of varied software tasks to accomplish and then waiting until the formal qualification test period to determine his compliance. Intermediate goals had to be established and used as management targets by both sides.

With these constraints in mind, the Government began negotiating a software incentive package with the contractor in early 1975. A set of four major efforts emerged, separately incentivized and to be accomplished serially. This would permit an intensive effort to be applied to each, with completion of one effort accomplished before the next was to begin. With the satisfactory completion of one of the tasks, the contractor would receive the incentive fee for that task, representing almost all profit to him over and above his separately funded costs. This provided the contractor with an extremely powerful incentive to comply with the Government desires.

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The first major task called for completing transitioning to the new compiler. The deliverable compiler (one hosted on the TACFIRE computer) was at that time not yet in regular use. (The first version was not accepted and a second version was written by another subcontractor). Software was still being generated by the compiler running on the IBM 360 system. Litton's task was to complete the new compiler and to demonstrate its proper functioning by taking the last compiled TACFIRE software, compiling it on the new system, executing the total system (operating system, applications programs, and maintenance and diagnostics), and comparing the results. This benchmark was satisfactorily completed in June of '75 and Litton received the full $200K incentive allocated to that task.

Next in the serial process came the correction of outstanding EPR's left over from the Find, Fix and Test mode. After careful review, the Government and the contractor agreed on 100 EPRs that were within the scope of the contract and still required correction. An incentive fee of $300K was attached to these EPRs, but with strings to ensure that the contractor did not simply fix the easiest (which constituted the majority) and then forfeit the remaining fee for the more difficult EPR's. The fee was so structured that fixing 80% netted payment of a third ($100K), 90% netted two thirds, and 100% would result in payment of the full $300K fee. Working with the CSC team, the PM further identified 42 of the 100 EPRs as the most difficult. To qualify for full payment of any of the fees, the criteria required that the applicable percentage of fixed EPRs had to include the same percentage of the 42 most difficult. The final result spoke well for both Government management and contractor performance in that all 100 EPRs were verified as corrected and the full $300K was paid.

Following completion of the old EPRs, attention now turned to the operating system. The existing system was still based on the use of the RAM drums and required shifting to an all-core memory system with the new MCMUs. Completion of this task could be determined readily by repeating the test that had earlier been used to verify the EPRs. If the same results were obtained with the system running in an all-core environment, it could be inferred that the OS was correct. This Litton did satisfactorily and they were awarded a $300K incentive fee.

In retrospect, the serialization process was not ideal with regard to the OS/MCMU task. The reason for this statement involves an understanding of the interface between the applications programs and the operating system. The OS work required modifications to the old applications programs to insert "hooks" for use by the OS, even though some of those old applications programs would be replaced later by new ones produced during the LP phase. The price paid for some "unnecessary" software work bought an early assurance that the all-MCMU concept was sound, however, and it appears to have been a good decision.

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The last element of the incentivized software work was a series of new software changes for the LP systems, including changes to the applications programs, operating system, and Maintenance and Diagnostic (M&D) programs. These changes constituted new work beyond the scope of the original contract and amounted to about $5M on the LP contract. A total of $200K incentive money was applied here, broken down into $100K on applications, $60K on OS, and $40K on M&Ds, each effectively on an "all or nothing" basis rather than further broken down.

The mechanism for testing for accomplishment of the LP changes was the standard Preliminary Qualification Test, or PQT. Earlier experience made it clear that PQTs in large measure determined the system to be delivered. As a consequence, considerable effort went into the test plan defining and formalizing the PQTs which were made subsets of the Formal Qualification Tests (FQTs). As structured, the test sequence provided for early visibility into the LP software.

The M&D changes were the first to be completed during the summer of 1976 and the only area in which no major problems were encountered. The biggest problems arose in making the required changes to the applications programs which were due to be completed in August to qualify for the incentive. Slippages occurred finally driving the date back to late September.

In the end, the contractor received the full incentive fee even though this had been on the all-or-nothing basis. Since the criteria had not formally been met (slippages had occurred, flow charts were not delivered), consideration flowed back to the government in the form of additional work on EPRs that had been determined to be out of the original scope. So for its $100K the government received about $65K-plus of additional work.

Much of the credit for the progress now being made on TACFIRE software must go to the cooperative working relationship which had developed between the government and the contractor, and the controls instituted through the new software management plan. The arms-length relationship had given way to a free and open working level interchange. Technicalities and formalities were replaced by a "let's figure out how to get the job done" attitude on both sides. The regularly scheduled software reviews included PM personnel, a user representative, and a tester (TECOM) representative. In addition to contractor management, actual programmer personnel participated directly. All of these were key ingredients for successful software development.

The door was also opened in November 1976 to solving the long standing problem of split responsibilities for software management. The decision had finally been made to reassign the tactical systems personnel of CSC to ARTADS. Almost immediately, they came under ARTADS operational control.

On balance, the LP phase software incentive program must be viewed as extremely successful. A tremendous amount of good work was accomplished in a relatively short period of time (about 18 months) with a very positive effect on the overall TACFIRE program. The combination of knowledgeable Government management, experienced software talent on the part of the contractor, and incentive money well applied paid off rather well.

Testing

A Test Integration Working Group (TIWG) had been formed and by August 1975 it had been fairly successful in implementing the concept of conducting a single series of integrated tests as opposed to many independent (and often redundant) tests conducted by different organizations for different purposes. Earlier, a significant achievement had been accomplished when TACFIRE successfully interoperated with the AN/TPQ-37 Artillery Locating Radar system.

First Article Tests (FAT) for the LP phase were scheduled to begin in November 1976, with software FQTs and systems and engineering tests at the contractor's facilities, and subsequent field tests at White Sands Missile Range. These would be followed by a Force Development Test and Evaluation (FDTE) which in part was scheduled in response to ASARC guidance to conduct a detailed review of Field Artillery command and control requirements and an analysis of potential changes in organization and doctrine that might be dictated by the introduction of TACFIRE. Out of FDTE would come the decision that the system was in fact ready to be turned over to the testers for conduct of DT/OT III.

First Article Tests ran essentially as scheduled, beginning on the first of November '76 and concluding in the 8th of May '77. The most serious hardware problem that arose during these tests was with the printer which had already been the subject of product improvement efforts as a reliability problem. The latest problem centered on paper handling capabilities in the tactical environment. The printer subcontractor was hard at work on a modification.

Software problems showed up during FAT also. The test plan and contract structure, however, had been designed to accomodate such problems. A total of six weeks of system tests were called for, with the start date contingent on the successful completion of FQT. Provisions for halting the tests had also been made. Problems uncovered during software FQTs resulted in a six week slippage in the start of the system tests which thus got underway on 28 February 1977. By the 15th of March it became apparent that enough problems existed to minimize the effectiveness of further testing at that point. The PM, however, was able to invoke the provisions of the contract to suspend testing and commence a mini Find, Fix and Test mode. On 4 March, FAT was resumed by rerunning portions of the system test through the point where they had earlier been halted. This time they proceeded on to termination with few problems.

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While problems had arisen, they had been realistically anticipated and provisions made to accomodate them. In contrast to earlier tests in which problems had caused major turmoil in the program, good planning had now allowed the PM to retain control of the situation and generally maintain the overall schedule.

Mission response times for the system were for the most part significantly improved as measured during FAT and compared to DT/OT II figures. In most cases this was due to the substitution of all electronic MCMUs for the slower RAM memories with their inherent electromechanical delays. The only response time problem areas were associated with long warning messages which simply required a comparatively long time to print. The actual times appeared to be within the range of acceptability however.

Continued progress was being made on the all electronic Digital Message Device (DMD) as an FFMED replacement. A contract for 15 engineering development models had been let in August 1975 for delivery in September-October 1976. A subsequent contract would provide for 82 LP models for use in DT/OT III.

FDTE commenced on 23 May 77 shortly after the completion of FAT. These tests proceeded without major problems, concluding at the end of July. However, they did not fully accomplish the objective of validating an analysis of the impact of TACFIRE since important feeder studies with data to be validated had not been completed in time. The stage was now set for DT/OT III, however, with DT III scheduled to run through August and September, and OT III planned to begin in January 1978.

Planning for Full Scale Production

It had become apparent to the PM that since limited production of TACFIRE would be completed in late 1977, and FSP could not commence until sometime in 1979 at the earliest (allowing time for post DT/OT III analysis and the ASARC/DSARC IIIa decision process prior to award, and then required lead times), a serious production gap would occur. High costs are associated with shutting down a production line and starting it up again some time later, aside from the potential loss of key personnel during the interim. Accordingly he developed, and in June 1976 submitted, a plan to bridge this gap with continued LP system production. The problem was intensified by a programming and budgeting decision, made in January 1977, which delayed an FSP target award date of July 1978 to October 1978 to move it into the next fiscal year. The PM's plan required Congressional approval which was requested in January 1977 and received in June. The distinction between LP and LRIP had now become somewhat blurred.

It had been the PM's plan to enter into separate negotiations with the contractor for a new contract to cover the additional LP phase.

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The CG, DARCOM[1] directed that this not be done, but that it be negotiated as a further modification of the original contract. The rationale for this decision was that the Government enjoyed greater leverage with the contractor by continuing with the original contract, under which Litton still had unfulfilled obligations. Negotiations took longer under this arrangement, but probably resulted in a better deal for the Government.

Negotiations were completed and Mod 190 was signed on 30 September 1977. Under the new contract modification, the Mod 88 FSP option was restructured into five separately priced options. The first two of these were aimed at filling the LP/FSP gap and the first was exercised immediately to produce an additional 8 sets at the approximate rate of one per month on conclusion of LP. The second would later permit that to be extended for an additional 10 sets.

Development Test/Operational Test III (DT/OT III)

DT III proceeded generally according to schedule. From the PM's point of view, software performance was very good, although this view was not shared by the testing community. The most significant problems were corrected by a single instruction change in one case, and replacement of a defective tape cartridge in the other. (The latter actually turned out to be partially a software problem also, and it was subsequently corrected with relative ease).

A number of other problems had been encountered during testing, however, and numerous corrections had been made to the software tape version being utilized. At one point, TECOM testers at White Sands wanted to terminate DT III testing altogether. TECOM headquarters instructed them to continue to assist the PM.

It had been planned all along that a new software tape would be prepared for OT III, incorporating all changes effected during DT III. As a result of the DT III testing difficulties, new tapes were validated at Ft Sill rather than White Sands. To some extent this compromised the independent tester role, although the operators had been provided by White Sands. The PM and testers remained at odds over the conduct of these tests.

In November of 1977, an informal General Officer review considered the question of whether or not the system was ready for OT III. TECOM presented a negative picture of the software based on their view of the DT III testing. Their position was rebutted by the PM who had confidence in the Ft Sill validations. The consensus reached at that meeting was that OT III should proceed.

Hardware reliability once again arose as a problem and again the printer was the prime villain. The DivArty system has two printers,

1
 Successor to AMC was the Development and Readiness Command (DARCOM)

allowing for some redundancy which reduces down time. Its DT III MTBF figure of 171 hours was comfortably above the 150 hour threshold. The Battalion set, with only a single printer, saw its reliability drop to 107 hours MTBF, below both the 150 hour figure and a 10% allowance.

These figures were to change following OT III to 95 hours MTBF for the battalion and 144 hours for the division set. While these figures fail to meet the stated requirement, they did not adversely affect the mission performance of TACFIRE during the conduct of OT III, which must be considered as the acid test of reliability. One must also consider that the magic number of 150 hours MTBF was in reality rather arbitrarily established many years earlier and inserted into the requirements document. The prime impact of the lower-than-planned reliability is that the maintenance workload is greater than anticipated and could affect the personnel requirements of the system. This would have to be reflected in the overall system COEA.

Aside from the reliability problem. OT III saw TACFIRE perform extremely well from the users' point of view. Fire planning was accomplished to a degree the manual system could never achieve both in quantity and quality of plans. Thousands of targets were processed at rates that only a sophisticated automated system could begin to handle. Continuity of operations, changes in support role assignments and other sophisticated command/control operations were performed with relative ease. In actual live fire, TACFIRE directed thousands of rounds successfully, with greater accuracy and flexibility of handling simultaneous missions than the manual/FADAC system. To be sure, several areas were found to be capable of being improved, but no serious shortcomings were encountered. In short, TACFIRE proved itself to the user as both an effective and necessary automated field artillery command/control system.

The testers once again had a negative view of the results. Their chief complaints centered on maintainability including logistical support, and fire mission processing. It is clear that TACFIRE has not achieved the MTBF and MTTR figures set forth in the QMR nearly twenty years ago. At the same time system availability has proved to be more than adequate. A higher price tag in terms of support requirements may have to be paid to realize TACFIRE's benefits. A number of software changes have been made to improve the fire mission processing performance.

VI. CURRENT PROGRAM STATUS

As this study is written TACFIRE is awaiting its final ASARC IIIa decision point. The ASARC is scheduled for October 1978, with that date dependent on the completion of the COEA. An FSP decision should consider COEA input which will include an analysis of tradeoffs between manpower and equipment, potential changes in organization and doctrine, and the potential impact of an equal investment in additional weapons and personnel.

29

To exercise the existing contractual FSP options, the Government must conclude its decision process in time for a December 1978 award date. A default on that date will automatically cost millions of R&D dollars due and payable to the contractor, as well as increased procurement costs that can be anticipated if it becomes necessary to negotiate a new FSP contract. The second option for an additional 10 sets has already been exercised to keep the production line open through the projected December award date; no additional slack remains.

TACFIRE has recently come under criticism by a special General Accounting Office (GAO) study group. The GAO group has recommended that FSP be delayed pending correction of numerous hardware and software deficiencies and has taken exception to the fact that the system scheduled for production is not the system that has been tested.

It is not the purpose of this study to refute the GAO points or even to be an advocate of TACFIRE. Nevertheless it must be said that in researching the information to be presented in this case study, little was found that could support the conclusions of the GAO study. The argument about differences in the production/tested systems may have some validity, but it does not appear to make good economic sense. Pressures for competition, improved performance, and maintaining state-of-the-art have resulted in numerous changes to individual items of TACFIRE equipment. Additional changes can be anticipated in the future as well, since TACFIRE will continue to be a dynamic evolving system. Certainly testing is called for when substitutions are made. The amount of testing required for any one item change will depend on the criticality of the item and the relative costs of testing. A system test comparable to a DT/OT sequence is neither necessary nor affordable. The same can be said for any equally large and complex system.

The current software status is exceptionally good. The handful (7 as of 31 May 1978) of current deficiencies must rank TACFIRE as one of the best software systems ready for deployment. Compared to most commercial systems of similar complexity, TACFIRE has an order of magnitude fewer deficiencies. The nature of the software beast is that a zero defects level is rarely achieved, and when claimed, more often than not is indicative of inadequate testing rather than super-clean software.

Only one major new software release will be delivered by the contractor. Following that, the Government feels it is prepared to accept full responsibility for subsequent software maintenance, with a support facility already in-being at Ft Sill, OK. If successful, an early transitioning of software support responsibility would also be a major accomplishment.

VII. SUMMARY AND CONCLUSIONS

By any objective standards, TACFIRE must be considered to be a success story, particularly from the software point of view. When one discounts the difficulties of the early years of comparative ineptness on both the contractor and government sides, the ensuing years saw closure on effective development and management techniques.

Several points raised through this study merit attention and review by project managers and system developers. The first of these is the concept of a "Find, Fix, and Test" mode and the developer/tester/user interfaces involved. Related to this is the critical role to be played by a formal "designated user." The importance of knowledgeable and experienced software managers has been cited, along with examples of good and bad incentive structures. These are the major items which have contributed to the success of the TACFIRE development.

This study also suggests that testing philosophy needs further examination on several fronts. The testing system has still not matured in its understanding or accomodation of software based systems. A "perfect" software system of any magnitude with zero deficiencies has yet to be developed, either in the commercial world or within the military. Much research is ongoing aimed at formal proofs of software "correctness", but the state-of-the-art for the foreseeable future will fall short of this objective. In the meantime, management decisions must be based on enlightened qualitative judgments rather than a simple quantitative tally of deficiencies.

Another area of concern is the question of who it is that the system developer must satisfy. Unfortunately there are many diverse players who do not speak with one voice. On the one hand, TRADOC may appoint a designated user or TRADOC System Manager (TSM) to work with the system developer. Yet not infrequently Forces Command (FORSCOM) or US Army Europe (USAREUR), for example, may have a very different point of view. Who is the "real" user? DARCOM has its own independent development tester in TECOM, while OTEA performs an independent operational testing function. These agencies are supplemented with others to perform analyses and independent reviews, such as the Army Materiel Systems Analysis Agency (AMSAA) and the TRADOC Systems Analysis Agency (TRASANA). A unique testing function is also performed within TRADOC by the Combined Arms Test Activity (TRACATA), and the many TRADOC boards have their own opinions of what a system should be and what its demonstrated performance has been. Moving up to the DOD level still others come in to play, not to mention the GAO and Congressional staffers. If this paragraph has confused the reader, than it has accomplished its purpose. This is the project manager's dilemma.

TACFIRE is not yet out of the administrative woods and a few remaining major hurdles must be cleared. From the technical management

point of view, the system has arrived. The gestation period has been about twenty years, but the baby is alive and well. Hopefully, it will soon be in the hands of the troops.

APPENDIX A

TACFIRE SOFTWARE

This appendix contains a description of the individual
TACFIRE computer programs. It is divided into three sections
covering Applications Programs, Operating System, and
Maintenance and Diagnostic Programs.

APPENDIX A

TACFIRE SOFTWARE

I. Applications Programs

At the battalion center an Ammunition and Fire Unit
Status program maintains current status information for all
fire units including their mission, location, weapon
strength and the types and quantities of ammunition avail-
able. Meteorological data are received, used and distributed
according to the needs of the battalion. Support maintains
current geometry data including zone of responsibility, front
line trace, no fire line, fire coordination areas, dead
space areas and air corridors. Tactical and Technical Fire
Control produces a detailed analysis of each target and
recommends the fire unit(s), number of rounds and type of
ammunition necessary to defeat a target. All of this is
accomplished considering the availability of ammunition and
the capability of each fire unit, as well as safety limits,
no fire lines and other control parameters. The computation
also produces ballistic data using meteorological and other
information about nonstandard and existing conditions. The
computer center provides complete and accurate fire commands
to the firing batteries. The Fire Planning program will

consider up to 15 fire units and 150 targets, analyze each
target for defeat against the fire unit(s) and ammunition
available and produce a complete schedule of fires. In
addition, a complete ballistic solution is generated for
each fire unit target pair and transmitted digitally to each
firing unit. The Artillery Survey program provides compu-
tations necessary to carry survey control forward to battery,
forward observer, target acquisition devices and target areas.

At Division Artillery the operational programs are similar
to those at battalion but expanded to provide computations
at this higher echelon. The Ammunition and Fire Unit Status
Program maintains status information on DivArty, Corps
Artillery, Air Force and Naval Units. Meteorological and
Support data are maintained for use by DivArty and FSE.
Tactical Fire Control provides defeat criteria for targets
at the Division level. Fire Planning is expanded over what
is available at battalion to include incorporating the nuclear
fire plan prepared by FSE. Artillery Survey permits survey
information centers at DivArty to disseminate survey control,
recompute survey information to establish common grids, maintain
trig lists and perform artillery survey computations. In
addition, and Artillery Target Intelligence program provides
for the complete processing of target information from all

sources. The computer correlates all target reports, combines related reports when appropriate and provides the most probable location and description of each target. The result is a complete, current and accurate target list at all times. This target list can then be provided to the fire planning routines at battalion, DivArty and/or FSE.

The FSE programs reside in the DivArty computer and share the Ammunition and Fire Unit Status, Artillery Target Intelligence, Meteorological and Support Functions. In addition, other operational programs are provided. Preliminary Target Analysis determines the most effective means of attacking targets, considering the capabilities within Division Artillery and the delivery means at Corps and Army, as well as tactical air and naval gunfire, when appropriate. The analysis considers high explosive, chemical, nuclear and special munitions. Based on these considerations and on guidance criteria established by the commander, the computer recommends the best munition and delivery means to defeat specific targets. Nuclear Target Analysis provides for a detailed nuclear target analysis considering commander's criteria, contingency and safety factors, availability, and allocation/assignment parameters. The analysis produces a recommended selection for each target, which includes the fire

unit, yield, height of burst and desired ground zero. In
addition, the computer displays the fraction of casualties
which can be expected and is capable of displaying other data
such as safety radii, radius of damage and maximum displace-
ment. This program performs vulnerability analysis and
damage assessments for both enemy and friendly bursts.
Nuclear Fire Planning then determines an optimum schedule of
nuclear fires within established criteria including pre-
initiation factors. Chemical Analysis determines the
casualty level which can be achieved and produces a recommended
selection for each target. This recommendation will include
fire units, chemical agent chosen, number of rounds required,
type of attack, desired points of impact and height of burst.
Fallout Prediction combines inputs from assumed or actual cloud
measurements with meteorological data, and fallout patterns
are predicted.

II Operating System

The hardware, software, communications, security and all
the rest of the TACFIRE components are integrated into a
cohesive system through a sophisticated operating system.
It is responsible for the real-time running of the application
and Maintenance and Diagnostic programs in response to input
messages from the various TACFIRE devices. It also formulates
and distributes the necessary output to the appropriate addressees.

The operating system is functionally divided into three categories: The stimulus receiver; the executive; and the supervisors. The stimulus receiver is responsible for handling interrupts. An interrupt is a signal that controls the hardware by signifying that a particular device is ready to begin processing or that processing has been completed. Through the use of interrupts, the stimulus receiver performs automatic priority processing. This function insures that high priority tasks such as fire missions are processed before lower priority ones. It also provides for time dependent functions such as performing periodic loop checks on the equipment and maintaining the time of day.

The stimulus receiver also provides the interface between the computer and the peripheral devices such as the Digital Plotter Map, Electronic Tactical Display, and Electronic Line Printer. The Executive performs resource allocation for all TACFIRE programs. A resource is anything in the system which must be shared by the software such as the central processor, execution time and the various input/output devices. These resources are managed by the executive on a multi-programmed basis; that is, two or more tasks running in an interleaved fashion by sharing these available resources.

The supervisors provide the housekeeping functions necessary for the orderly receipt, storage and transmission of messages. The data management function controls the allocation and storage of files in memory. The message processing supervisor verifies the authenticity of a message, posts a warning if the message is from an unauthorized source and logs the message. It's also responsible for message traffic over the digital data terminals. For outgoing messages, it breaks them into segments, if necessary, initiates the transmission of each segment and receives an acknowledgement from the receiving station that the message has been received. Incoming messages are checked for proper addressing and completeness. If the message is proper, the message processor sends an acknowledgement. Otherwise it generates a warning message. The Artillery Control Console support supervisor responds to operator requests thus providing the man-machine interface.

III Maintenance and Diagnostic Programs

Reliability standards of the TACFIRE system are achieved in part through the use of a Maintenance and Diagnostic (M&D) software package. The M&D programs are constantly running so that equipment faults are rapidly detected. Additional programs can then be initiated which isolate the fault to a small group of digital cards within the faulty device. Using a fault catalogue and a GO - NO GO built in circuit card tester,

the failed card is then found and replaced. When a fault
is detected within a computer center, graceful degradation
occurs when possible. Thus, mission processing can
continue and repair deferred until the tactical situation
permits. In the event that a computer center fails
completely, a lateral backup capability exists so that an
adjacent computer center can immediately assume the mission
of the failed computer. Thus, TACFIRE is a highly reliable
tactical system capable of providing uninterrupted mission
processing under combat conditions.

APPENDIX B

USER DETERMINATION ITEMS (UDI's)

This appendix contains two representative TACFIRE User
Determination Messages. Message Nr. 1 is dated 30 August 1972.
Message Nr. 41 is dated 18 January 1978. Due to its length,
portions of Message Nr.41 have been omitted.

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PTTEZYUW RUWTROE1107 2431809-EEEE--RUEOFUA.

ZNY EEEEE

P 301801Z AUG 72

FM CGUSAFACFS FTSILL OK //ATSFA-PL-FY//

TO RUEADWD/HQ DA //DAFD//

INFO RUEDPDA/CGCONARC

RUEONGA/CGUSAMC

RUEOFUA/CGUSACDC

RUEOFUA/CGUSACSC FTBELVOIR VA

RUEOGDA/CGTECOM APG MD

RUEOPRA/PMARTADS FTMONMOUTH NJ

RUWTFHA/CGUSACDC COMSGP FTLEAVENWORTH KS

RUEOFUA/CGUSACDC INCSGP FTBELVOIR VA

RUEBLRA/CGUSACDC PALSGP FTLEE VA

BT

UNCLAS E F T O FOUO

SUBJ: TACFIRE USER DETERMINATION MSG NR 1

A. REF MSG HQ DA. DAFD-DC. SUBJ: TACFIRE, DTG 172247Z AUG 72.

1. IN COMPLIANCE W/REF MSG, THE FOL USER DETERMINATIONS HAVE BEEN
MADE:

ITEM 1-1: DEFICIENT AREA - QMR PARA 7B(2)(A)1F (7B(2)(A)2G) STATES
THAT BN (DIVARTY) TACFIRE COMPUTER SHALL BE CAPABLE OF COMM

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PAGE 2 RUWTROE1107 UNCLAS E F T O FOUO

SIMULTANEOUSLY ON 12 (20 FOR DIVARTY) HALF DUPLEX OR FULL DUPLEX

COMM CHANNELS (FLD WIRE OR RADIO) W/OTHER COMPUTER CEN AND REMOTE

DEVICES ON REAL-TIME BASIS. SUF SPACE MUST BE PROV IN VEHICLE TO

PERMIT INSTL OF 12 (20 FOR DIVARTY) DATA MODEMS WO COMPROMISING

OP SPACE RQRMTS AND WO UNDUE ELECTRICAL ALTERATION. ARTY BN AND

DIVARTY COMPUTERS HAVE ONLY 4 DIGITAL DATA TERMINALS EA. ONLY 1

COMM CHANNEL (WIRE OR RADIO) IS PROV BY EA DATA TERMINAL. THUS BN/

DIVARTY FDC CEN ARE PROV W/ONLY 4 CHANNELS EA (EPR'S KE 37, DE 344).

USER DETERMINATION - 4 COMM CHANNELS WILL NOT SAT COMM RQRMTS AT

BN FDC'S OR DIVARTY. WO RADIO/WIRE INTEGRATION CAPABILITY. MIN OF

9 DIGITAL DATA TERMINALS (DDT'S) ARE RQR AT BN. SHOULD RADIO/WIRE

INTEGRATION CAPABILITY BE PROV, 6 DDT'S WOULD SAT CURRENT BN RQRMT.

INTEROP RQRMTS W/OTHER DIGITAL DATA SYS (TDS) DICTATE NEED FOR 2

ADD DDT'S IN FUTRUE. BN CONFIGURATION DES BY USER IS RADIO/WIRE

INTEGRATION DEVICE SUCH AS MONITORING, PATCHING, AND CONTROL UNIT

(MPCU) W/6 DDT'S AND W/PROVISIONS TO ADD 2 DDT'S IN FUTURE. AT

DIVARTY, CURRENT RQRMT IS 7 DDT'S WO RADIO/WIRE INTEGRATION, OR 5

W RADIO/WIRE INTEGRATION. PROV TO ADD 2 DDT'S AT DIVARTY IS

ALSO RQR.

ITEM 1-2: DEFICIENT AREA - TACFIRE CONS ICM FIRST WHEN PERS TGT IS

PAGE 3 RUWTROE1157 UNCLAS E F T O FOUO

ATK. ICM IS ALWAYS MORE EFF THAN ANY OTHER SHELL/FUZE COMB AGAINST
PERS. THEREFORE TACFIRE ALWAYS CHOOSES ICM UNTIL ICM IS EXHAUSTED,
UNLESS FIRE MSN IS RECOMPUTED USING ALTER OPTION. CMDRS MOD MSG DO
NOT PROV MEANS TO REORDER PROJ/FUZE CONS ORDER. SINCE LARGE AMTS OF
ICM ARE NOT NORM AVAIL DUE TO COST OF RD, A CMDR SHOULD HAVE MEANS
OF REORDERING SELECTION. (EPR L4-434)

USER DETERMINATION — CMDR'S MOD SHOULD BE CH TO INCL AMMO SELECTION
CRITERIA. THIS WILL ALLOW CMDR TO INFLUENCE CHOICE OF AMMO WO
HAVING TO DELAY PROCESSING BY RECOMPUTATION.

ITEM 1-3: DEFICIENT AREA — MIL-STD-1472A, PARA 5.7.3.4. REQ VERT
ADJ FOR SEAT IS FROM 16 TO 21 IN. SEAT IN BN AND DIVARTY SHELTER
HAS VERT ADJ FROM 17-1/2 TO 21 IN. (EPR L4-314)

USER DETERMINATION — PRES SEAT ADJ IS SAT.

2. FROM USER'S STDPT, FOL GEN PRIORITY ORDERING APPLIES FOR CORR
DEF AND SHORTCOMINGS IDENT IN EPR'S:

    A. FIRST, THOSE DEF WHICH HAMPER CONT OF ET/EST.

    B. SECOND, THOSE DEF WHICH DO NOT HAMPER CONT OF ET/EST BUT
WHICH, IF NOT CORR PRIOR TO END OF ET/EST, WILL CAUSE FINDING OF
UNSUITABILITY.

    C. THIRD, ALL OTHERS.

PAGE 4 RUWTROE1107 UNCLAS E F T O FOUO

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3. DET LIST OF EPR'S GP BY PRIORITY FOR CORP IS BEING PROV TO PM
ARTADS UNDER SEP COVER. "GDS CLASSIFICATION 29 AUGUST 1973."
BT
#1107

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TO: CDR USATRADOC FT MONROE VA//ATCD-CF//

CDR DARCOM ALEXANDRIA VA//DRCRDO-O//

CDR USATECOM APG MD//DRSTE-FA//

CDR USAOTEA WASHINGTON DC//DACS-TEM//

PM ARTADS FT MONMOUTH NJ//DRCPM-TDS-TF//

CDR USACACDA FT LEAVENWORTH KS//ATCACC-CF//

CDR USALOGC FT LEE VA//ATCD-CF//

CDR USAEPG FT HUACHUCA AZ//STEEP-MT-NW//

DIR HEL//APG MD//DRXHE-HE//

CDR USAECOM//FT MONMOUTH NJ//DRSEL-MA-CA//

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CDR USAECOM/FT MONMOUTH NJ//DRSEL-NL-BA-2//

DIR USAMSAA//YPG MD//DRXSY-RW//

CDR USAARDCOM//DOVER NJ//DRDAR-SCF-C//

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TROY MADISON, DAC ATSF-CD-TD
39-5607, 16 JANUARY 1978

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DD FORM 173

REPLACES DD FORM 173, 1 JUL 64, WHICH WILL BE USED

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MESSAGE HANDLING INSTRUCTIONS

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TO:

ZEN/C TACFIRE FIELD O FT SILL OK//DRCPM-TDS-TF-FS//

ZEN/CDRTCATA/ATTN: ATCAT-CAD-TF/FT HOOD TX//

UNCLAS E F T O

SUBJECT: TACFIRE (DMD) USER DETERMINATION MESSAGE NO. 41

A. LTR, HQDA, DAFD-DOT, 7 SEP 73, SUBJECT: TACFIRE PROGRAM STRUCTURE.

B. MSG, USAFACFS, ATSF-CT-ME, 6 APR 73, SUBJECT: TACFIRE TERMS OF REFERENCE.

C. PRIME ITEM DEVELOPMENT SPECIFICATION FOR DMD FOR TACFIRE, EL-SS-2603-7F, 7 APRIL 1975.

ITEM NO. 41-1: DEFICIENT AREA: BATTALION SYSTEM FAILED TO GENERATE WARNING ON RECTANGULAR REPLOT WHEN QE CHANGE WAS LESS THAN 1 MIL. (L4-3638).

USER DETERMINATION: CURRENT SYSTEM DESIGN AND OPERATION IS ADEQUATE.

RATIONALE: THE TARGET LOCATION IS CORRECTED IN THE FM FILE AS A

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FROM:

TO:

RESULT OF THE RECTANGULAR REPLOT THUS SHOULD FIRE BE RE-

INITIATED ON THE TARGET NEW BALLISTIC CALCULATIONS ARE PERFORMED

AGAINST THE NEW LOCATION. THE OUTPUT OF THE WARNING IS NOT CRITICAL

TO SAFETY AT THE TIME REPLOT IS PERFORMED AND THIS WARNING IS

A CURRENT CANDIDATE FOR SUPPRESSION TO REDUCE THE VOLUME OF

PRINTER OUTPUT.

ITEM NO. 41-2: DEFICIENT AREA: SYSTEM FAILED TO DELETE TARGET

AS REQUESTED BY ATI; CDR. (L4-3639).

 SER DETERMINATION: CURRENT SYSTEM DESIGN AND OPERATION IS

CORRECT.

RATIONALE: SEVERAL PAGES OF PRINTOUT ARE MISSING AND TOTAL ANALYSIS

OF THIS ORIGINAL PROBLEM IS NOT POSSIBLE. SEVERAL SPECIFIC SCENARIOS

HAVE BEEN ATTEMPTED TO CREATE THE PROBLEM, HOWEVER, THE SYSTEM IS

NOW WORKING CORRECTLY. THE SCENARIOS WERE RUN ON MASTER TAPE

VERSION #82 on 9 DECEMBER 1977 AND 14 DECEMBER 1977. THIS EPR

SHOULD BE WITHDRAWN AS NON-REPRODUCIBLE.

ITEM NO. 41-3: DEFICIENT AREA: SYSTEM APPEARED TO FAIL TO USE

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FROM:

TO:

ALL FU SPECIFIED IN FM; CAP ANALYSIS. (L4-3640).

USER DETERMINATION: CURRENT SYSTEM DESIGN AND OPERATION IS

CORRECT.

RATIONALE: THE USE OF UFFES WITH THE FM; CAP; MESSAGE LIMITS

CONSIDERATION TO ONLY THOSE UNITS SPECIFIED. THE PROBLEM DESCRIBED

CANNOT BE REPRODUCED ON VERSION #82 MASTER TAPE. VERIFICATION

OF CURRENT PROCESSING ON VERSION #82 TAPE WAS RUN ON 9 DECEMBER

1977 AND 14 DECEMBER 1977. THE EPR SHOULD BE WITHDRAWN AS NON-

EPRODUCIBLE.

ITEM NO. 41-4: DEFICIENT AREA: TACTICAL FIRE CONTROL PROCESSING

AT DIVISION ARTILLERY APPARENTLY VIOLATED FCA. (L4-3645).

USER DETERMINATION: CURRENT SYSTEM DESIGN AND OPERATION IS

ACCEPTABLE.

RATIONALE: IN EACH CASE, THE SYSTEM DETECTED THE FCA VIOLATION

AND PRINTED THE NAME OF THE FCA AND THE ORGANIZATION WITH WHOM

COORDINATION WAS REQUIRED AND ONLY THE TYPE MUNITION RESTRICTION

WAS NOT SHOWN.

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BOOK NO

MESSAGE HANDLING INSTRUCTIONS

FROM:

TO:

ITEM NO. 41-21: DEFICIENT AREA: RFAF:X WAS INCORRECTLY GENERATED

ON TARGET WHICH HAD BEEN DEFEATED. (L4-3613).

USER DETERMINATION: CURRENT SYSTEM DESIGN AND OPERATION IS

CORRECT.

RATIONALE: SEVERAL ATTEMPTS WERE MADE ON VERSION #82 TAPE TO RE-CREATE

THE PROBLEM AND THE SYSTEM IS OPERATING CORRECTLY ON 14 DEC 77.

THE EPR SHOULD BE WITHDRAWN AS NON-REPRODUCIBLE.

ITEM NO. 41-22: DEFICIENT AREA: SYSTEM FAILED TO PRODUCE MFR

EN MISSION WAS ENDED FOR FU WHICH BECAME OUT OF RANGE DURING

ADJUSTMENT. (L4-3585).

USER DETERMINATION: CURRENT SYSTEM DESIGN AND OPERATION REQUIRES

CORRECTION.

RATIONALE: WHEN FIRE MISSIONS ARE ENDED FOR ANY FU, THE MFR

SHOULD BE PRODUCED IN ORDER TO PROVIDE FOR PROPER AMMUNITION

ACCOUNTING.

ITEM NO. 41-23: DEFICIENT AREA: KG ALARM FAILURE OVERLOADS THE

COMMUNICATIONS NETWORK. (L4-3737).

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FROM:

TO:

USER DETERMINATION: CURRENT SYSTEM DESIGN AND OPERATION IS CORRECT.

RATIONALE: THE PROBLEM DESCRIBED IN THE EPR WAS CORRECTED BY

SOFTWARE IMPLEMENTATION OF ECP 504 ON MASTER TAPE VERSION #80.   A

HARDWARE RETROFIT OF CABLES IS PRESENTLY UNDERWAY FOR ALL SYSTEMS

AND WILL BE FINISHED PRIOR TO THE START OF OT III.   THE EPR SHOULD

BE DOWNGRADED TO INFORMATION.

ITEM NO. 41-24:   DEFICIENT AREA: SYSTEM REQUIRES INTERVENTION

TO CORRECT MESSAGE FORMAT RECEIVED FROM REMOTE SUBSCRIBERS.

4-3560).

USER DETERMINATION: CURRENT SYSTEM DESIGN AND OPERATION IS CORRECT.

RATIONALE: REMOTE VFMED SUBSCRIBERS ARE PROVIDED THE CAPABILITY

TO CALL FOR AND RECEIVE THE STANDARD MESSAGE FORMATS FROM COMPUTER

CENTER.   WHEN MESSAGES ARE USED PROPERLY AND FILLED OUT PROPERLY

THEY THEN ENTER THE COMPUTER AS THOUGH THE ACCO HAD COMPLETED

THEM.   THERE IS NO SYNTAX AND WHEN A REMOTE SUBSCRIBER CHANGES

PUNCTUATION THERE CAN BE NO CHECK UNTIL THE MESSAGE GOES TO SYNTAX.

ITEM NO. 41-25:   DEFICIENT AREA: THE PCLD TABLES AT BATTALION AND

DISTR:

DRAFTER TYPED NAME, TITLE, OFFICE SYMBOL, PHONE & DATE

SPECIAL INSTRUCTIONS

TYPED NAME, TITLE, OFFICE SYMBOL AND PHONE.

SIGNATURE

B-11   CLASSIFIED

DATE TIME GROUP

JOINT MESSAGEFORM						SECURITY CLASSIFICATION	EFTO
						UNCLASSIFIED	

PAGE	DRAFTER OR RELEASER TIME	PRECEDENCE ACT INFO	LMF	CLASS	CIC	FOR MESSAGE CENTER/COMMUNICATIONS CENTER ONLY		
							DATE – TIME	MONTH YR
1/ OF 1?		RR PP		EEEE				

BOOK NO	MESSAGE HANDLING INSTRUCTIONS

FROM:

TO:

DIVISION ARTILLERY GENERATED UNEXPECTED DELAYS OR WARNINGS.

(L4-3098, L4-3099).

USER DETERMINATION: CURRENT SYSTEM DESIGN AND OPERATION IS

ADEQUATE.

RATIONALE: TWO SPECIFIC PROGRAM CHANGES HAVE BEEN MADE WHICH

IMPACTS OPERATION IN THIS AREA.   THE XMIT TABLE ALLOCATION PRO-

CEDURE WAS OPTIMIZED TO PROVIDE FOR INCREASED UTILIZATION OF ALL

AVAILABLE DDT'S.   THE OUTPUT RESULTS PRIORITY WAS CHANGED TO

PROVIDE FOR THE SAME PRIORITY AS THE INPUT MESSAGE INITIATING

THE TASK.   THE PCLD PRIORITIES ARE OPERATOR CONTROLABLE AND SHOULD

OPERATIONAL NEED DISCLOSE THAT CHANGES ARE WARRANTED, SUCH CHANGES

CAN BE MADE, AS REQUIRED.   THE REMAINING PROBLEM CONCERNING

EXCESS WARNINGS CONCERNING CLASSIFIED DATA GOING TO THE DMD WILL

NOT BE RESOLVED UNTIL ALL DEVICES HAVE CRYPTO GEAR AND UNTIL SUCH

TIME THE WARNINGS ARE NECESSARY.

ITEM NO. 41-26:   AMENDMENT TO MESSAGE #37, 7 OCT 77.

USER DETERMINATION ITEM NO. 37-7, CONCERNING EPR L4-3549, IS

DISTR:

DRAFTER TYPED NAME, TITLE, OFFICE SYMBOL, PHONE & DATE	SPECIAL INSTRUCTIONS

TYPED NAME, TITLE, OFFICE SYMBOL AND PHONE

SIGNATURE

UNCLASSIFIED EFTO

		SECURITY CLASSIFICATION					ELTO

UNCLASSIFIED

PAGE	ORIGINATOR RELEASER TIME	PRECEDENCE ACT INFO	LMF	CLASS	CIC	FOR MESSAGE CENTER/COMMUNICATIONS CENTER ONLY	
OF 19		RR FC		EEEE		DATE - TIME	MONTH YR

BOOK NO

MESSAGE HANDLING INSTRUCTIONS

FROM:

TO:

AMENDED TO READ:

USER DETERMINATION: CURRENT SYSTEM DESIGN AND OPERATION IS

ACCEPTABLE.

RATIONALE: THE CONOPT MNEMONIC HAS BEEN ADDED TO NNFP: FC;

AND FM: FC; MESSAGES WITH BCS INTERFACE TAPE. FOR THOSE UNITS USING

MUNITIONS WHICH DO NOT CONTAIN SUCH CAPABILITY THE DATA WILL

SIMPLY BE IGNORED.

ITEM NO. 41-27: DEFICIENT AREA: BATTALION TTFC PROGRAM WAS GEN-

ATING FUZE SETTING FOR PDA FUZE IN FIRE COMMANDS. (L4-3678).

USER DETERMINATION: CURRENT SYSTEM DESIGN AND OPERATION IS CORRECT.

RATIONALE: SEVERAL SCENARIOS WERE RUN ON MASTER TAPE VERSION #82

ON 9 DECEMBER AND 14 DECEMBER AND THE PROBLEM CANNOT BE REPRODUCED.

THE SYSTEM IS PROVIDING THE EXPECTED OUTPUTS IN EACH TEST SCENARIO.

THE EPR SHOULD BE WITHDRAWN AS NON-REPRODUCIBLE.

ITEM NO. 41-28: AMENDMENT TO MESSAGE #32, 12 JULY 1976.

USER DETERMINATION: ITEM 32-5 RATIONALE IS AMENDED TO DELETE

THE FOLLOWING: "PENDING IMPLEMENTATION OF SUCH CHANGES DTM

DISTR

DRAFTER TYPED NAME, TITLE, OFFICE SYMBOL, PHONE & DATE

SPECIAL INSTRUCTIONS

TYPED NAME, TITLE, OFFICE SYMBOL AND PHONE

SIGNATURE

UNCLASSIFIED

DD FORM 173

REPLACES DD FORM 173, 1 JUL 68, WHICH WILL BE USED.

BOOK NO

MESSAGE HANDLING INSTRUCTIONS

FROM:

TO:

CLASSIFICATION IS REQUIRED".

RATIONALE: NUCLEAR UPDATE STATEMENT OF WORK INCLUDES CORRECTION

OF THIS DATA.

ITEM NO. 41-29:   AMENDMENT TO MESSAGE #32, 12 JULY 1976.

USER DETERMINATION ITEM 32-6 RATIONALE IS AMENDED TO DELETE THE

FOLLOWING: "DTM CLASSIFICATION IS REQUIRED FOR OPERATOR PERSONNEL

AND ANALYSTS."

RATIONALE: NUCLEAR UPDATE STATEMENT OF WORK INCLUDES CORRECTION OF

THIS DATA.

6593210

0

DISTR:

DRAFTER TYPED NAME, TITLE, OFFICE SYMBOL, PHONE & DATE   SPECIAL INSTRUCTIONS

TYPED NAME, TITLE, OFFICE SYMBOL AND PHONE

SIGNATURE

B-14   ASSIFIED

DATE TIME GROUP

DD FORM 173   REPLACES DD FORM 173, 1 JUL 68, WHICH WILL BE USED.

APPENDIX C

FIND, FIX, TEST MODE MEMORANDUM OF AGREEMENT

This appendix consists of a copy of the actual Memorandum
of Agreement between the PM, ARTADS and Litton Data Systems
Division covering the mode of operation in effect during
the TACFIRE Find, Fix and Test mode.

MEMORANDUM OF AGREEMENT

29 March 1973

SUBJECT: FIND, FIX, TEST MODE (FFTM) OF Operation

SCOPE:

1. Upon the signing of the TACFIRE Contract Modification Number P00088 by signatory parties, the present government test mode will be discontinued and a Find, Fix, Test Mode (FFTM) initiated. Broad guidelines as to the ground rules under which the FFTM will proceed are as outlined herein. The FFTM will extend from date of execution of the Contract Mod until the start of the government Systems Integration Test.

2. At FFTM start date equipment configuration at Fort Sill and at White Sands Missile Range (WSMR) are predicted to be as follows:

   a. Fort Sill - ET/EST DivArty and 4 Bns.

   b. WSMR - TSS DivArty augmented

3. Within two weeks of start of the FFTM one Bn with out-of-shelter kit and BDU (less personnel, KG and GFE used outside of the shelter) will be shipped to Litton, Van Nuys and one complete Bn system will be shipped to WSMR.

4. Tasks to be accomplished during the FFTM include:

   a. DTM rewrite by contractor personnel is to be undertaken during the FFTM
   ? frame. This effort will involve support by government personnel. Operator maintenance personnel input as well as equipment time for tool proofing will be required. These operations will be dovetailed with the FFTM and accomplished in parallel with such operations to preclude impact thereon.

   b. During the FFTM the contractor will endeavor to fix all known software problems. The contractor will be permitted to take leniencies with the system tapes (i.e.: access patches) in order to facilitate and expedite the fielding of solutions to problems. System tapes so modified shall not be used for government verification of fixes or ET tests.

   c. During the FFTM the Government will verify that software problems have in fact been corrected. Tapes supplied to the government for checkout and determination of contractor progress must be under configuration management and have been processed through the presently established tape verification procedures in the Van Nuys facility.

   d. During the FFTM the contractor will deliver the software packages to implement the COMSEC procedures, FSO procedures and the necessary software to permit use of the new devices. The provisions of paragraphs b and c above will apply.

e. During the FFTM the contractor will take the actions necessary to correct current hardware deficiencies and introduce replacement and/or retrofitted devices. Equipments transported between field sites and the contractor facility for repair, retrofit or new device engineering will be moved in an expedited fashion. All rofitted equipments returned to the field, or retrofits performed in the field, st be discreetly marked and accompanied by appropriate documentation. Rigid management of changing equipment configurations by both the contractor and the government must be maintained in order to track progress toward complete establishment of the DT/OT II baseline configuration.

f. During the FFTM the government will, as possible, verify that hardware deficiencies have in fact been corrected. Although at both Fort Sill and WSMR the FFTM will be the primary effort, the government will on a non-interference basis conduct verification testing and other new testing that may be required to qualify the TACFIRE system.

g. Formal and OJT of newly assigned government operator and organizational maintenance personnel will be conducted during the FFTM time frame. It is the government's intent to accomplish this training on a non-interference basis with FFTM operations. These operations, in turn, must minimally impact on the training operations. Therefore, the government and the contractor mutually agree that in the switch-over of operations every attempt will be made to leave the systems in readiness for the subsequent operation. General Plan of training to be conducted, locations and schedule is at Incl 1.

5. General approach to operation during the FFTM will be:

a. At each test site the government will provide 2 (1 PM ARTADS, 1 TECOM) d the contractor one individual to comprise a FFTM Control Team. They will meet larly to discuss requirements, schedules, plans, differences, etc. Whenever ssible utilization of equipment will be planned at least one week in advance. The government will provide the necessary operators, supervisors and evaluators, within reason, to insure completion of the objectives outlined by the contractor. The contractor will have on hand sufficient supervisory, engineer, analyst, and software expertise to support these objectives and adequately complement government personnel.

b. During FFTM organizational and DS/GS Maintenance will be performed by contractor personnel with assistance as required from government personnel. Either by observation, report, or other means government evaluators must be informed, in detail, of all maintenance actions. Use of parts, float, and flow of material to and from depot maintenance will follow already established procedures.

c. When problems are encountered processing will be interrupted only long enough to gather that data necessary to support an EPR.

d. System output and dumps from FFTM will be available for the contractor after appropriate security requirements are met. Arrangements for copies for, or transfer to, the government for its investigations will be made on an individual, as requested basis. Output and dumps from government test periods will be provided the contractor on an as requested basis.

e. Government analyses of system outputs will be provided contractor personnel expeditiously in order to insure rapid corrective action of expected problems.

f. Government produced run logs will be provided contractor personnel on a daily basis. Consolidated maintenance forms will also be provided as required.

g. In the event of failure in a given DivArty or Bn system and no contractor personnel appear within one hour on site to remedy the failure, the government may, at its discretion, cease operations on that system for the remainder of the shift. In the event the agreed to numbers of contractor personnel are on-site working in another area the above will not apply.

h. Periods as indicated in Inclosure 2 will be devoted to government designated activities primarily aimed at review, check and test of contractor's progress in correcting faults and conduct of ET. During these periods the government will operate the equipment, pull scheduled and deferred maintenance, and be the primary force in the control of operations. Contractor personnel may monitor government operations and should be available to lend software, hardware, and analytical support.

i. No more than ½ day every week will be required by the government to comply with mandatory training directives. Scheduling of such training will be accomplished so as to minimize impact on FFTM operations.

j. A general plan for planned software corrections (EPR related) and issue of revised tapes is at Inclosure 2.

k. A general plan for planned hardware corrections (EPR related) and replacement equipments is at Inclosure 3.

l. A general plan for introduction of software changes to implement replacement equipments is at Inclosure 4.

m. A general plan of currently planned contractor test efforts at Fort Sill and WSMR is at Inclosure 2.

n. Combined government-contractor management reviews will be conducted on a quarterly basis to determine progress toward DT/OT II commencement and to resolve problems that may arise. This shall not preclude more frequent informal reviews that may be required.

o. As a demonstration that the required work has been accomplished and that the system is in fact ready for DT/OT II testing a system integration test will be conducted at Fort Sill, OK. Requirements for this testing are as indicated in Contract Mod Number P00098.

p. During the FFTM additional Operator and Maintenance personnel training is required. Operator training will be given via government OJT. DS/GS Maint personnel are to be trained by the contractor. All training will be scheduled for minimum impact on the FFTM. Place and date of training is to be determined, depending on the availability of personnel and equipment. (Incl 1 for detail).

q. The general plans described above can be modified by the FFTM Control Team on a case by case basis upon mutual agreement between contractor and PMO ARTADS representative.

ECIFIC DETAILS:

1. The effort at Fort Sill will be broken down into two parts:

   a. Part I: Contractor tests

   b. Part II: Government testing and training

These parts will be merged into one continuous schedule which will, based on events, be adjusted by the FFTM control team.

2. Specific contractor tests are as indicated in Incl 2 to find problems as reflected in Fort Sill EPRs and solutions thereto. Other efforts will include upgrading of equipment and introduction of new/revised items.

3. Government testing will include efforts to clear previous EPRs, monitor contractor progress and continue system evaluation. Training of OTEA and FABd personnel will be conducted as shown in Incl 1 & 2.

4. Personnel Requirements:

   (a) Government - Appropriate Test Directors, operator and maintenance personnel, pertinent test witnesses and evaluators.

   (b) Contractor - Test Director, Software and Hardware specialists appropriate test being run, maintenance personnel.

5. For DT/OT II, the DivArty TSS must be re-established as a Maintenance Facility, checked out, and made operational. Scheduling and activities must take this into account.

6. The effort at WSMR will be broken down into two parts:

   a. Part 1 - Contractor tests

   b. Part 2 - ET Runs and tape check-out

These parts will be merged into one continuous schedule which will, based on events, be adjusted as required by the FFTM control team. An estimated 8 hours/day, 5 days/week run time on the equipment will be required to complete the schedule by the time the equipment must be directed to other uses. The TSS DivArty augmented and one ET/EST Bn, will be devoted to this effort. Should requirements arise for training, deferred maintenance, manual check-out, or miscellaneous needs separate and distinct from the main stream effort of the 2 subparts described above, they will be undertaken during normal shift operations on a non-interfering basis or be deferred to a special separate shift.

7. Contractor tests: Specific software check-outs as indicated at Incl 2 to find problems as reflected in WSMR EPRs and solutions thereto. Other efforts will include upgrading of equipment and introduction of new/revised items.

ET Runs and Tape check-out. On the operations side, FSE, COMSEC (ITCI/ICD), tape check-out and selected portions of RMRT are to be accomplished. Hardware tests in EMP, shelter drop and S-250 Road have yet to be performed. Finally, some ET requirements for newly introduced devices or for reruns due to changes wrought by configuration alterations may have to be addressed. While emphasis is placed on the FSE/COMSEC/RMRT tests, scheduling must provide for accomplishment of the remainder. To preclude impact during the latter stages of FFTM and on DT/OT II, EMP should immediately be accomplished. The EMP test will be run under restrictive conditions to be supplied by the contractor which will limit the possibility of catastrophic failure. Emphasis will then be placed on COMSEC/FSE/RMRT runs with the remaining tests integrated into the schedule.
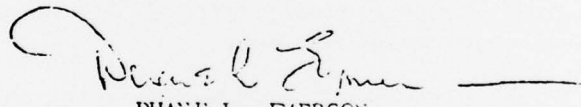
9. Personnel Requirements.

    a. Government - Appropriate Test Directors, operator and organizational maintenance personnel, pertinent test witnesses and evaluators.

    b. Contractor - Test Director, Software and Hardware specialists appropriate to test being run, DS/GS maintenance personnel.

10. It should be noted that the DTM reorganization and Litton training have not been contracted for as of this date.

HAROLD J. EHLERS
TACFIRE Program Manager
Litton DSD Representative

DUANE L. EMERSON
Colonel, GS
Director, TACFIRE
Contracting Officer's Representative

C-6

APPENDIX D

LIST OF ACRONYMS

ADFSC	Automatic Data Field Systems Command
ADP	Automatic Data Processing
ADSAF	Automatic Data Systems for Army in the Field
AMC	Army Materiel Command
AMSAA	Army Materiel Systems Analysis Agency
AR	Army Regulation
ARTADS	Army Tactical Data Systems
ASARC	Army Systems Acquisition Review Council
CCIS	Command and Control Information Systems
CDC	Combat Developments Command
CDR	Critical Design Review
CG	Commanding General
COEA	Cost Operational Effectiveness Analysis
CORADCOM	Communications Research & Development Command
CPFF	Cost Plus Fixed Fee
CRT	Cathode Ray Tube
CSC	Computer Systems Command
CS3	Combat Service Support System

DA	Department of the Army
DARCOM	Development and Readiness Command
DCP	Development Concept Paper
DDR&E	Defense Director of Research and Engineering
DDT	Digital Data Terminal
DIVARTY	Division Artillery
DMD	Digital Message Device
DOD	Department of Defense
DS	Direct Support
DSARC	Defense Systems Acquisition Review Council
DT	Development Test
ECOM	Electronics Command
ECP	Engineering Change Proposal
EPR	Equipment Performance Report
EST	Expanded Service Test
ET	Engineering Test
ETD	Electronic Tactical Display
FAA	Field Artillery Agency
FADAC	Field Artillery Digital Automatic Computer
FAT	First Article Test
FDTE	Force Development Test and Evaluation
FFMED	Fixed Format Message Entry Device

FIELDATA	Field Data
FORSCOM	Forces Command
FQT	Formal Qualification Test
FSDR	Functional System Design Requirement
FSE	Fire Support Element
FSP	Full Scale Production
GAO	General Accounting Office
GS	General Support
LP	Limited Procurement
LRIP	Low Rate Initial Production
MCMU	Magnetic Core Memory Unit
M&D	Maintenance & Diagnostic
MOD	Modification
MTBF	Mean Time Between Failures
MTTR	Mean Time to Repair
OD	Operational Deficiency
OS	Operating System
OSD	Office of the Secretary of Defense
OT	Operational Test
OTEA	Operational Test and Evaluation Agency

PDR	Preliminary Design Review
PM	Project Manager
PQT	Preliminary Qualification Test
PRC	Planning Research Corporation
PSSA/B	Programming Support System A/B
QMR	Qualitative Materiel Requirement
RAM	Random Access Memory
R&D	Research and Development
RDAT	Research and Development Acceptance Testing
RECAP	Review and Command Assessment of Projects
SAR	Selected Acquisition Report
SRB	Software Review Board
SSEB	Source Selection Evaluation Board
TACFIRE	Tactical Fire Direction System
TACVAL	Tactical User Validation Committee
TECOM	Test and Evaluation Command
TIWG	Test Integration Working Group
TOS	Tactical Operations System
TPP	Total Package Procurement
TRACATA	TRADOC Combined Arms Test Activity
TRADOC	Training and Doctrine Command

TRASANA	TRADOC Systems Analysis Agency
TSM	TRADOC Systems Manager
USAAMS	US Army Artillery and Missile School
USACGSC	US Army Command and General Staff College
USACONARC	US Army Continental Army Command
USAEPG	US Army Electronic Proving Grounds
USAREUR	US Army Europe
UDI	User Determination Item
WSMR	White Sands Missile Range, NM